Department of Media, Aalto University

BECOMING OTHER

Virtual Embodiment – Blurring the Self-Other Binary

Daniel Landau

Aalto University

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Virtual Embodiment – Blurring the Self-Other Binary

Daniel H. Landau

Aalto University
School of Arts, Design and Architecture
Department of Media

Supervising professor
Lily Diaz-Kommonen, Aalto University, Finland

Thesis advisors
Doron Friedman, Interdisciplinary Center Herzliya
Lily Diaz-Kommonen, Aalto University, Finland

Preliminary examiners
Prof. Mel Slater
Prof. Christa Sommerer
Prof. Laurent Mignonnneau

Opponent
Prof. Mel Slater

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Abstract

Aalto University, P.O. Box 11000, FI-00076 Aalto www.aalto.fi

Author
Daniel Landau

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Abstract
The research presented here explores the impact of virtual reality (VR) and virtual embodiment technologies on the distinction between 'self and other' in interpersonal and intergroup contexts. In a series of five empirical experiments and three art projects, I investigated this self-other distinction in the context of the ever-evolving relationship between technology and the self.

Using stereoscopic 180° video, I explore the impact of virtual encounters transitioning from meeting others to becoming 'the other.' The first study shows that meeting in VR a person who shares a painful story elicits a high degree of empathetic care and facial synchrony. The next study shows that experiencing ingroup aggression from an outgroup perspective increases empathy towards the outgroup compared to seeing the same scenario from the ingroup's perspective. Next, I present an art project devising a novel and effective technique to induce virtual embodiment using 180° stereoscopic video, followed by empirical evaluation and validation of this technique. Next, I show that meeting yourself in virtual reality as an experimental paradigm can increase self-compassion. And finally, in a VR museum installation, I demonstrate the potential of VR for social impact.

This manuscript explores various VR methods of placing participants "in others' shoes" and provides both new insights and novel methods for using VR and virtual embodiment for storytelling, art installations, and social interventions.

Keywords Virtual Reality, Empathy, Virtual Embodiment, Perspective taking, Intergroup conflict, Techno-Self, Body ownership illusion

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Acknowledgments

They say it takes a village to raise a child. It also takes an intellectual community to create meaningful multifaceted knowledge.

As a multidisciplinary artist and researcher, collaborative work is the DNA of my work. It took numerous collaborations to materialize this artistic and academic work. This manuscript is a culmination of years of work inspired by and relating to growing up in Jerusalem in the 1970s and 1980s, dealing with many questions related to social identity and forming my personal identity. Throughout my career, as I developed each project and designed each experiment, I enjoyed the input of many conversations and collaborations that enriched the artistic and intellectual scope of the knowledge it relates to, and hopefully generates and inspires others.

I dedicate this thesis to my mother, who seeded my creative practice; my father, who inspires my academic thinking; my older sister, the artist Sigalit Landau, whose monumental artwork and totality inspired me to go with my vision with no hesitation; my younger sister, the neuroscientist Ayelet Landau, whose phenomenal research and dedication have inspired my critical investigative thinking; and last but not least, my beloved wife Michal Oppenheim-Landau, without whose support, this work would not have materialized.

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I conducted this research while working for the Israeli startup 'ActiView.' Although it is an industry-oriented enterprise, the vision of its leadership and its entrepreneurial spirit made this company an exciting testing ground for much of the work presented here. Projects produced at ActiView included experimental storytelling and analysis, as well as modeling human behavior. My work with this fantastic team of coders, animators, engineers, producers, and data scientists has significantly impacted my exploration of virtual reality. Going to work every day and being surrounded by people who share similar passions was extremely fertile. I would like to express my warmest thanks and sincere appreciation to the founders of ActiView - Matanel Libi, Gil Asher, and Tal Koelvin - for bringing together such a creative group of people.

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And finally, this dissertation was born due to the transformative meeting with Prof. Doron Friedman. I met Doron on the committee of a conference that I had organized, and it is from that point that I started one of the most exciting intellectual journeys of my carrier. Doron invited me into his lab (The Advanced Reality Lab at the Interdisciplinary Center Herzliya) and into the world of research and scientific thinking. More than an academic dialog, it turned out to be an incredibly profound ongoing conversation that covered art, philosophy, neuroscience, and beyond. Many of these conversations took place on our travels to China, New York, and Germany, among other places. With his quiet and understated style, Doron is a significant inspiration for the work presented here.

To all the artist and scholars who took part in my art performances and empirical experiments by helping me to conceptualize, and realize these projects, thank you for your time, expertise, and creativity:

Eran Halperin, Yossi, Hasson, Yoni Levi, Hai Cohen, Maya Magnat, Carmel Vaisman, Lior Zalmanson, Duffy Katz, Hedva Eltanani, Shani Bar, Ruti Tamir, Nadav Barnea, Shai Govhari, Shahar Marcus, Samira Saraya, Yair Sugarman, David Rudoy, Aviv Kegen, Daniel Meir, Hagar Brotman, Ron Rochman, Elad Ozeri, Eitan Hayak, Sraya Harif, Abed Natour, Emil Landau, Shahar Marcus, and Noga Rozman.

Special thanks to all the participants in the experiments, with special heartfelt thanks to the Sabatin and Avidan-Levi families.

Last but not least, I would like to thank my beloved children, Alma, Emil, and Raphael, for helping me put this research in the perspective of exploring the joyful and complex process of forming one's identity.

Tel Aviv, August 2020
Daniel Landau

The evolution of desktop publishing: Three generations of writers, from right to left: my grandfather's Triumph mechanical typewriter, my Mothers' OLYMPIA electronic typewriter, my MacBook Pro laptop

List of Articles

Article I: Exposure to social suffering in VR boosts compassion and facial synchrony
Accepted pending revision, Accepted July 27, 2020, Computers in Human Behavior

Article II: The Enemy's Gaze: Immersive Virtual Environments Enhance Peace Promoting Attitudes and Emotions in Violent Intergroup Conflicts.
Published: September 11, 2019, PLOS ONE
https://doi.org/10.1371/journal.pone.0222342

Article III: Virtual Reality-based Conflict Resolution: The Impact of Immersive 360° Video on Changing View-Points and Moral Judgment in the Context of Violent Intergroup Conflict
Accepted May 2020, New Media and Society

Article IV: Virtual Embodiment using 180° Stereoscopic Video
Published: June 07, 2020 Frontiers in Psychology https://www.frontiersin.org/articles/10.3389/fpsyg.2020.01229/full

Article V: Meeting Yourself in Virtual Reality: A Performative Experiment in Self-Compassion
Published Leuven University Press, *shifting Interfaces. An Anthology of Presence, Empathy, and Agency in 21st Century Media Art*
ISBN: 9789462702257, **Publication**: May 29, 2020, **Languages**: English
https://lup.be/products/123857

Author's Contribution

Article I: First co-author.

Article II: The author initiated the VR study and conceptualized the design of the experiment. He developed the virtual reality scenario, wrote the script and directed the actors.

Article III: The author initiated the VR study and conceptualized the design of the experiment. He developed the virtual reality scenario, wrote the script and directed the actors.

Article IV: First co-author.

Article V: First author.

List of Art Projects:

Art Project I: Time-Body Study
Performative Experiment at Print Screen Festival,
22-25 June 2016, Holon

Art Project II: Visitors
Media Installation, Israel Museum Jerusalem,
June 2018 - May 2019, Jerusalem
https://www.imj.org.il/he/content/%D7%91%D7%99%D7%A0%D7%99%D7%A0%D7%95%D7%99%D7%97%D7%93-%D7%95%D7%9C%D7%91%D7%93

Art Project III: Self-Study
Performative Experiment at B3 Film Festival
9-18 October 2017, Frankfurt
https://www.b3biennale.de/Daniel-Landau-EN.html

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1. INTRODUCTION

1.1 Preface

I grew up in the French Hill - a suburban Jewish neighborhood in North-East Jerusalem. The terrace houses covered the hill slopes in repetitive structures – and on bright winter days, I could see a part of the north section of the Dead Sea from our balcony. Much closer, not more than three-hundred meters away, across a small valley, I could see the Arab village of Isawiya (Figure 1.1). There too, the houses covered the hills, but, as opposed to the grid-like planned housing project of the French Hill (Figure 1.2), the way the houses of Isawiya were built on the mountainous terrain had no apparent structure. The village seemed like flora that grew over time, responding to the landscape, and blending into its curves. The divide between the communities was always apparent. The differences were on every level – religious, socio-economic, political, and municipal. Five times a day, the voice of the Muezzin echoed throughout the whole valley – the slow, repetitive verses had an enchanting effect on me. Mainly, I noticed the way that the sound traveled the terrain of the valley, sounding different every time. Soundscape and landscape merged – bridging the two communities and ignoring the divides. Although the sense of us-vs.-them was very concrete in the reality I grew up in, I refused to accept it. From very early in my professional life, many of my projects addressed the Israeli-Palestinian conflict. However, as I sought to understand the core of this conflict, I was drawn deeper into layers of abstractions that ended up distancing me from the political reality and leading me to search the realms of culture, psychology, and philosophy to gain an understanding of what set the two people apart. In this process, I mapped various axes of forces and entities that form the narrative of my identities (Table 1.1).

Figure 1.1: Panoramic view of the French hill (left) and Isawiya (right)

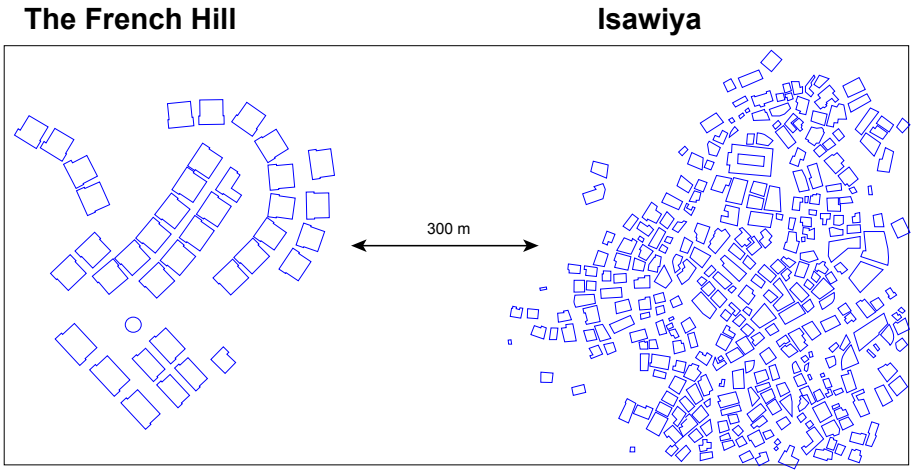

Figure 1.2: Top view of housing formation, French hill (left) and Isawiya (right)

Table 1.1: Dichotomies of entities

IDENTITIES	ABSTRACTIONS
French Hill – Isawiya	Sound-Terrain
Israel – Palestine	Grid – Rhizome[1]
West – East	Technology – Tradition
Jews – Arabs	Self-Other

Finally, the collective sense of us-vs.-them has led to my focus on a personal self-vs.-other. In other words, the axis I will be navigating is between the social identity of ingroup-outgroup - whether the other is a member of one's group (ingroup) or a member of a group the person does not belong to (outgroup), and the personal identity of self-vs.-other.

The divide between the self and others is one of the most fundamental gaps in human existence; its essence is captured in Jean-Paul Sartre's observation "Hell is other people" (Sartre, 1968 p. 45). However, what if we could not only study the impact of technology on the self, but devise interventions that would allow us to understand the other (sympathy), feel what they feel (empathy), and want to act to relieve their pain (compassion)?

This study is the culmination of two decades of work, thoughts, and contemplations on the question of the self and the other. Each project examines

1 Rhizome is a philosophical concept developed by G. Deleuze and F. Guattari in their Capitalism and Schizophrenia (1972–1980) project. It refers to the construct of "image of thought," based on the botanical rhizome, that suggests multiplicities.

different aspects of this subject, trying to reflect and process the possibility of bridging the self-other gap, e.g., what makes us see a group or an individual as part of us as opposed to a threatening stranger? Here it is, in the hope that my artistic and empirical research will contribute to understanding what sets us apart and devising interventions that bring us together.

1.2 Reflection on Artistic Research

This manuscript resides within the interdisciplinary fields of sci-art (Morris, 2000) and artistic research (Balkema, 2004). In this chapter I will reflect on the meaning of these terms in the context of scientific research, artistic practice, and their intersection. Research is "any systematic creative activity undertaken in order to increase the stock of knowledge, including knowledge about the world, humanity, culture, and society, and the use of this knowledge to devise new applications (OECD, 2008)." Indeed, research is at the base of every scientific activity – empirical or conceptual, quantitative or qualitative – continually moving back and forth between theory and observations to generate new knowledge. But what does artistic research mean? What is behind the field of Art and Science? In order to address these issues, it is important to understand first what artistic research is. To do so, I start by presenting a series of questions, which I will then answer briefly:

- Do art and science share similar intrinsic motivations?
- Can science be poetic?
- Can art be empirical?
- What are the limits of quantifying phenomena?
- What are the limits of artistic impressions?
- Does artistic research have to rely on theory?
- What type of data does artistic research collect?
- What type of knowledge does artistic research produce?
- Does art need to have a well-defined research question?
- What societal role do art and science play?

These questions are critical for the framework of this art/science dissertation since there are many pitfalls in such interdisciplinary work – namely, the creation of hybrid work that is less than the sum of its components, lacking the depth and focused of disciplinary practices. However, the potential of sci-art projects is to integrate interdisciplinary sources of knowledge into new insights and knowledge that are impossible to reach without a holistic view nurtured from many sources of knowledge. Therefore, the field of sci-art holds the potential of combining the understanding of mechanisms and their meaning (Table 1.2).

Science - Mechanism
Art - Meaning

Figure 1.3: The different essence between art and science

Since the training, practice, and institutions of science and arts are vastly different, it may seem difficult to integrate them into a cohesive discipline. To illustrate this possibility, I will describe the process that shifted my work from being strictly art-based to also relying on the empirical scientific realm. In 2014, I organized a conference and exhibition to explore the complex human-technology relationship in the philosophical framework of Posthumanism. The idea was to have both academic and artistic perspectives contribute to this broad, multifaceted question of the human-technology relationship. Together with Udi Edelman (Israeli Center for Digital Art, Holon, Israel), I curated the art exhibition titled: "HELA, Forms of Human Existence," and with Dr. Carmel Vaisman (Tel Aviv University, Israel) and Prof. Doron Friedman (Interdisciplinary Center Herzliya, Israel) I organized a three-day conference titled: *The Aesthetics and Politics of Posthumanism*. Intuitively, we understood that the ambitious scope of these questions goes beyond a single discipline or practice, but rather requires a multi-facet critical conversation.

Following the conference, I was invited as an artist in residence to Prof. Friedman's Advanced Reality Lab at IDC, Herzliya, which focuses on two main technologies – brain-computer interfaces and virtual reality. Both technologies offered experimental grounds to explore the human-technology relationship. Gradually, I got involved in several research projects, learning a practice that I have never used before. A few of our initial studies were defined as exploratory. I felt very comfortable designing experimental setups, creating new relationships with technology without exactly knowing what I was looking for. The main difference between my scientific work and my regular artistic practice was the process of gathering data. As an artist, I found the scientific act of gathering data to be a fascinating process. I was no longer relying on random feedback from audience or critics, but on a systematic method for measuring the impact of the intervention. This was a new level of observation for me. While artists typically observe phenomena in the world and respond to them, in empirical studies, a crucial part of the process is a two-way flow of information, in which participants experience a simulation, and in return, the data is collected by the investigator. Some artists even proclaim to disregard the audience's response altogether, in order to maintain independence and freedom of thought. In contrast to artworks, most scientific experiments are not set to create an experience, but only to stimulate a response and measure the outcome. What if each approach could accommodate its counterpart's mode of operation?

In what follows, I will try to address the questions I raised in this section in an attempt to understand the potential of artistic research:

Do art and science share similar intrinsic motivations?

In order to understand the natural and physical world, science observes it by measuring and analyzing phenomena in empirical experiments (Churchland and Van Fraasen, 1990). Art, on the other hand, observes the natural and physical world and subjectively responds to its meaning (Gude, 2008).

Can science be poetic?

Many scientific and intellectual practices require isolating variables with the goal of arriving at rational outputs. However, even if the goal is not poetics, the results can be very much so. For example, the work of physicist Eshel Ben Jacob produces highly esthetic artifacts as part of his empirical studies, terming it Bacterial Art (Ben-Jacob and Levine, 1998).

Figure 1.4: Bacteria art, and research developed by Prof. Eshel Ben-Jacob, The Maguy-Glass Professor, in Physics of Complex Systems, School of Physics and Astronomy at Tel Aviv University.

Can art be empirical?

Since the mid 20th century, the boundaries of art have been expanded into the realm of conceptual art. Art did not have to be confined to original, crafted artifacts. Ready-mades, theory, and conceptual work have become a legitimate and accepted practice by the artistic community (Alberro, 1999). But does this mean that artists have become theorists, philosophers, or scientists? What sets modern and post-modern art apart from the scientific world is that the artifacts produced by artists are contextualized within the discourse of the art world, presented in museums, galleries, and art events. For example, in 2002, conceptual artists Rod Dickinson created a re-enactment of Dr. Stanley Milgram's 1961 social psychology experiment 'Obedience to Authority.' The re-enactment has been exhibited over twenty times in contemporary art museums across the world (e.g., the Australian Centre for the Moving Image, Melbourne, Australia; the Science Museum, London, England, Exhibition: 'Pain' 12 Feb - 20 June 2004).

However, data gathering in an art event holds significant challenges, which makes it a boisterous setting for running empirical studies. When designing an experiment, the need for precise and controlled variables often conflicts with the multilayered art experience. I would argue that in terms of experience, artistic artifacts and controlled experiments contrast in their fundamental essence:

- Artistic artifacts focus on complex, multilayered output.
- Empirical experiments focus on well-defined research questions.

In Art Project II, I discuss my Open Lab platform, addressing these issues. In these art events, I attempted to create lab conditions that allow running full-scale empirical experiments.

The tension between internal validity and external validity

Two of the most important requirements of scientific studies are internal validity and external validity. Internal validity is the degree to which a study establishes a reliable causal relationship between an action and an outcome. In contrast, external validity is the degree to which the results of a specific study can be generalized to other settings. In many experimental designs, there is a trade-off between internal validity and external validity. Namely, the more an experiment is controlled, the harder it is to generalize its results across other contexts. However, despite efforts to study phenomena with creative paradigms that favor external validity, there are often layers of insights missing when translating rich phenomena into empirical practices, such as the contextual meaning of these models on both personal and societal levels.

Indeed, as long as we are interested in prediction and control, art holds no advantage upon science. For example, if we want to predict how many people will contract Covid 19, art will probably not be useful. However, if we want to

assess the impact that the Covid 19 world crisis may have on individuals and society, art may provide significant insights beyond what science can provide. Similarly, the topics of this dissertation seem infinitely rich and art may be able to provide additional insights, beyond those obtained in controlled studies.

What are the limits of artistic research?

Within certain artistic communities, the artistic practice, the act of 'doing-art' lacks systematic, methodical structure (Díaz-Kommonen, 2002), and, in many cases, it relays on a subjective impression, which may tell us more about the observer than about the object of observation (Dobrez, 2011).

Does artistic research have to rely on theory?

Artistic research can be an investigation of human movement, emotions, social topics, or scientific practice. All these investigations require an in-depth understanding of the subject matter. Hence, when an artist observes or gets inspired by scientific knowledge, the better they understand the theory, the more rooted their response.

What type of data does artistic research collect?

Beyond quantified data, which can be legitimate input for artistic practices, artistic research has access to qualitative data and intuition. Some may dismiss such resources as esoteric. However, the scope of knowledge obtained beyond the scientific realm from these non-measurable sources may contribute to the wealth of meanings. For example, a choreographer may instruct a group of dancers to recall a happy childhood memory and have the body respond to this memory. Such open-ended instruction leaves a lot of room for the subjective experience of the dancers, but it may also provide profound insights into the link between memory and movement.

What type of knowledge does artistic research produce?

I argue that art's goal is not necessarily to produce structured knowledge, but to reflect, subvert, and raise awareness. Artistic Research invites 'open-ended thinking.' Therefore, rather than formal knowledge, it is the thinking in, through, and with art that is the core of artistic research (Borgdorff, 2011). There are many theories that resist the idea of art being knowledge. For example, Descartes articulated knowledge as "clear and distinct" ideas (DeRose, 1992), and John Dewey describes art as "distinctively aesthetic" (Dewey, 2012) with its own "integrity" that lifts it above knowledge.

Can an experience be a source of knowledge? Rooted in the philosophy of Maurice Merleau-Ponty, there is growing consensus regarding the role of the body in producing, sharing, and storing knowledge, which is formulated in the field of embodied cognition (Johnson, 1989). Hence, an experience that might include emotion, cognition, and participation can be a multi-channel vehicle to knowledge that may have an impact beyond a scientific paper. This idea locates

knowledge within the experience rather than beyond it. Immanuel Kant argued that thought and sensation depend on one another (Kant, 2003). On this basis, the meanings that can be found in art, rather than dismissed as subjective, may have an effect on the wider circle of concepts through which a subject is defined and articulated.

Does art need to have a well-defined research question?

There are many points of departure for art projects:

An artist can enter the studio, not knowing what their subject or output will be. Their motivation for the process can be internal observation. In this case, the process does not necessarily begin with a well-defined question; however, such a question might form during the creation process.

In contrast, an artist can initiate a creative process with a theme in mind. Here too, they can approach the well-defined theme without narrowing the process to a precise question. The artist may choose to hold-on to multilayered aspects of the theme, knowing that reducing the complexities to a single research question might mitigate the impact of the artifact. Artistic research may reach a research question after an exploratory process, followed by additional questions. I would argue that artistic research seldom stems from a single research question and rarely if ever, produce well-defined, conclusive results.

What societal role do art and science play?

Many artists and scientists devote their work to impact society in a positive way (Latter, 2019). In favor of this discussion, it is vital to bring the humanities perspective, which broadens the scope of what is considered science. One of the aspects shared by humanities and the arts is the position of societal critique. However, a significant difference between art and science is the action in which art conveys its message. Since the mid 20th century, most art has sought to break away from traditional forms of presentation, leading to the birth of site-specific installation, site-specific performance art, public art, and art in the community (Colpitt et al.,2004). This means that as part of the artistic process, the artist may think like an entrepreneur – exploring unconventional ways for their art to reach an audience and create impact.

Finally, I propose that art and science are not separate domains but rather two dimensions in a shared cultural space. Together, they have the capacity to investigate phenomena and contribute to knowledge at large. In this respect, the diagnosis of the French philosopher Bruno Latour applies here *mutatis mutandis*: “There are no two departments but only one, their products to be distinguished later and after joint examination” (Latour, 1991, p. 190). So, at the very least, the two fields are not mutually exclusive, so that not everything that is considered art must, therefore, be unscientific, and vice versa, not everything that is regarded as science must be unartistic.

The German artist, Florian Dombois, proposes a manifesto with ten commandments for Art as Research (2006):

Table 1.2: Florian Dombois, "Art as Research" manifesto

FLORIAN DOMBOIS, ART AS RESEARCH
"Art as Research" presupposes an epistemic interest.
The epistemic interest is clearly stated.
Knowledge is formulated within the respective art form.
A grouping according to subjects complements the classification by a form of representation.
Research is done by many people, not only one person.
The evaluation of the results of research is carried out by experts.
The results are made accessible to the general public via publication.
Quality criteria are agreed upon for the discussion of research results.
"Art as Research" takes into account the "State of the Art."
"Art as Research" can take up the solutions scientific research offers and bat them back as questions.

1.3 Research Questions

In the course of our lives, every event, interaction, or encounter holds the potential to change who we are. For example, being injured in a car accident, becoming paralyzed, and confined to a wheelchair can result in a person defining themselves as handicapped. But in ordinary circumstances, our identity evolves gradually. We form our identity around narratives that allow us to tell the story of who we are. But what would it be like to participate in an experience so immersive that it makes you believe the events and your presence are real? Could such an experience be as profound as a car crash, transforming you in one instance?

In what follows, I address the power of Virtual Reality (VR) and virtual embodiment to affect our identity. The main research question of this thesis is: what is the impact of virtual reality and virtual embodiment experiences on the self-other gap (RQ1)? And once we understand this impact, the secondary research question is: what does this impact mean for art installations, narrative-storytelling, and social interventions (RQ2)?

Over a decade of research has shown that virtual embodiment experiences have the capacity to change attitudes, opinions, and behavior)Hasler et al., 2017; Tussyadiah et al., 2018; Morina et al., 2015). But what will these findings mean, once VR and virtual embodiment 'leave the lab' and become an integral part of our life? What would be the impact of VR and virtual embodiment on how we tell stories, create art, and devise social interventions?

1.4 Structure of the Dissertation

This dissertation consists of five empirical studies and documentation of three art exhibitions. Each contributes to the understanding of how VR and virtual embodiment hold the transformative potential to blur the self-other gap (RQ1), and what they mean for art and social change practices (RQ2).

Table 1.3: List of research outcomes (empirical and artistic) and their key findings.

RESEARCH QUESTION	ART AND SCIENCE PROJECTS	KEY FINDING
RQ1	**Article i**: Exposure to Social Suffering in VR Boosts Compassion and Facial Synchrony	2D vs. VR media-comparison study shows that Immersive VR elicits a significantly higher degree of **empathetic** care.
RQ1, RQ2	**Article II**: The Enemy's Gaze: Immersive Virtual Environments Enhance Peace Promoting Attitudes and Emotions in Violent Intergroup Conflicts.	Experiencing ingroup aggression from the perspective of the outgroup increases empathy towards the outgroup compared to seeing the same scenario from the ingroup's perspective.
RQ1, RQ2	**Article III**: Virtual Reality-Based Conflict Resolution: The Impact of Immersive 360° Video on Changing View-Points and Moral Judgment in the Context of Violent Intergroup Conflict	In the 2D vs. VR media-comparison, we found that the immersive experience of the check-point scene led to more hostile emotions towards the soldiers (but not more empathy towards the Palestinians) and thereby resulted in the judgment of the soldiers' actions as less moral and less justified, compared to seeing the same scenario as a 2D video on screen
RQ1	**Article IV**: A virtual embodiment using 180° Stereoscopic Video	180° Stereoscopic video can provide an effective technique to induce the experience of Virtual Embodiment.
RQ2	**Article V**: Meeting Yourself in Virtual Reality: A Performative Experiment in Self-Compassion	Meeting yourself in virtual reality as an experimental paradigm to increase self-compassion.
RQ1, RQ2	**Art Project I**: Visitors	VR museum installation holds the potential for social impact
RQ2	**Art Project II**: Time-Body Study	180° video virtual embodiment holds the potential for high impact embodied storytelling. The experience resulted in a high emotional impact on the participants.
RQ2	**Art Project III**: Self-Study	Design intervention holds the potential to elicit a transformative experience

As previously described, in my investigation of the gap between self and other, I tackle the issues of private and social identities. In the next chapters, I argue that virtual embodiment can elicit the illusion of being in another person's body and the merge of the self and the other. Therefore, each one of the artistic and empirical projects presented here can be placed on the following continuum: Self-Other Merge, and Private-Social Self (Figure 1.4).

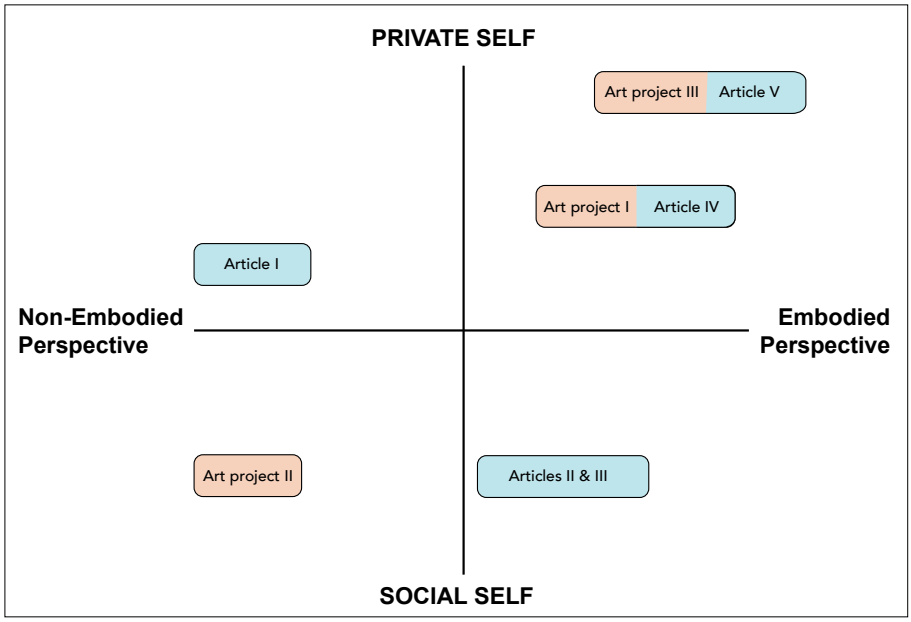

Figure 1.5: Placing the articles and art projects on a two-axis graph. Projects are placed between the continuum of non-embodied – embodied perspective, and on the continuum of social self and private self.

Table 1.4: Mapping art and academic publications

Project	Private/ Social	Point of View	Degree of Self-Other Merge
Article I: Exposure to social suffering in VR boosts compassion and facial synchrony	Private Identity	1PP, No Virtual Embodiment Face to face	Other sitting in front of the participant
Art Project I: Visitors	Social Identity	1PP, No Virtual Embodiment Face to face	Other sitting in front of the participant
Article II & **III:** The Enemy's Gaze & VR based Conflict resolution	Social Identity	2PP Over the shoulder	Other's Perspective
Article IV: A virtual embodiment using 180º Stereoscopic Video & Self Study	Private Identity	1PP Virtual Embodiment - Other	Other's Body
Article V and Art Project III: Self-Study	Private Identity	1PP, Virtual Embodiment - Self	Meeting Self as Other

2. BACKGROUND

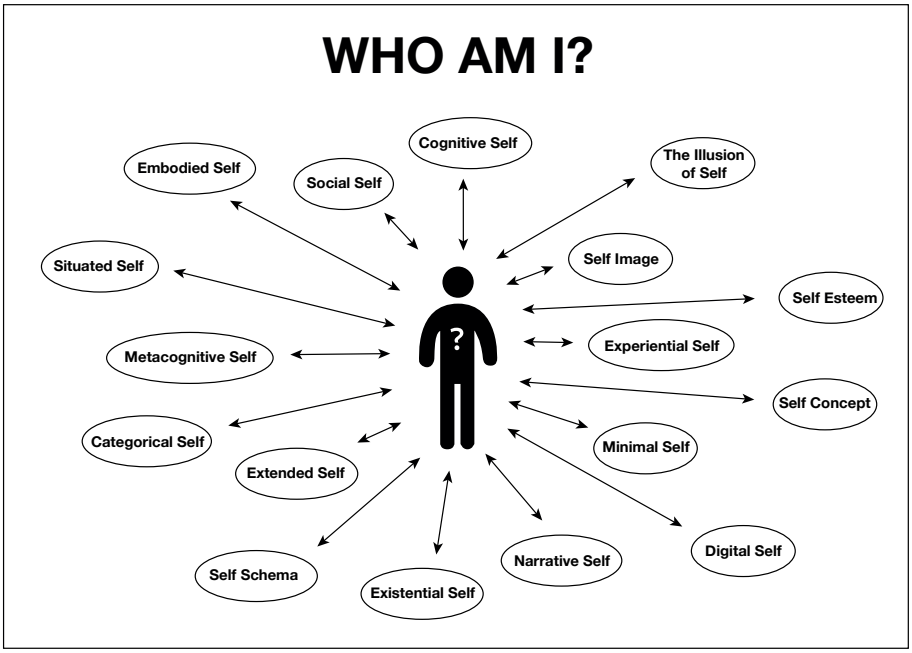

Figure 2.1: Different knowledge perspectives on the construct of the self.

2.1 The Self

What does it mean to have or to be a self (Figure 2.1)? How do we know that the self actually exists (Lindhom, 1997; Taylor, 1995)? What is the fundamental difference between the self and the other? The self-other binary is probably one of the most basic constructs of human consciousness and identity, suggesting that the existence of an 'other,' which is different than the self, permits the recognition or possibility of a self (Asendorpf, Warkentin, and Baudonniere, 1996), i.e., when a 'self' (= me) sees an 'other' (= you) but does not control its body or hear its thoughts. The 'self' is separate. The 'other' is not the 'self.' Hence, the self is me. Rooted in Western philosophy (Sartre, 1943; Hegel, 1807), the self-other binary is fundamental to the modern social fabric (Ping, 2018). But is the construct of the self strictly a relational one, or is it an independent and stable entity of itself?

Our behavior is context-dependent, and it is very fluid compared to the stable and robust sense of being a unique self, or being "who I am" (Bamberg, 2011, p. 6). We can change our behavior and still consider ourselves the

owners of the same stable self. In the digital society, more than ever, we shift between many physical or digital contexts, while performing, presenting, and maintaining different identities (Maczewski, 2002).

Whether the origin of the construct of selfhood is relational or independent, selfhood is conceived to be fundamental to survival (Higgins, 2018). Its goal is to reduce the uncertainty in the world. This idea is rooted in social identity theory in which the conscious processes of anticipating one's action and the other person's response helps reduce uncertainty in the world (Hogg, 2016, 8). Contemporary thought in the multidisciplinary field of studying the self distinguishes between the minimal self, the metacognitive self, and the narrative self (Nelson et al., 2014, 479).

2.1.1 The Minimal Self

The minimal self is the most fundamental part of the self-concept. It is a pre-reflective, bodily, implicit self-awareness that characterizes our waking life from our early infancy onwards. The claim is that at least a minimal sense of 'mine-ness,' which marks our experiences, formed as early as the age of two. The minimal self is the sense of being separate and distinct from others. Each of us is an entity or object separate and distinct from other objects or people. Article IV introduces a method to elicit the illusion of owning a body different from your own. Can virtual embodiment expand the notion of what a minimal self is? Can we have several minimal selves?

2.1.2 The Metacognitive Self

The metacognitive self is the process of being able to think about oneself. It is becoming aware that although we are separate and distinct objects, entities, or beings, we also exist in the world. It plays a vital role in reducing uncertainty in the world. The metacognitive self is what allows us to imagine performing an action, going somewhere, interacting with others, and imagining the consequence of that action (Decety and Grezes, 2006, Hertzog and Dunlosky, 2011).

2.1.3 The Narrative Self

The narrative self is constituted through the stories that we tell of ourselves and that others tell of us. The sum of events and interactions that we accumulate throughout our life establishes the notion of who we are. The construct of the narrative self also results in categorizing one's self. Typically, young children categorize themselves by age, gender, or size, sometimes even by some skills they possess. You can hear young children say: "I'm three" or "I'm five," "I'm a girl," or "I'm a boy." In early childhood, children apply to themselves concrete categories. Eventually, as we grow older, we start to categorize ourselves also according to internal psychological traits (Hirsh and Peterson, 2009). We begin to compare ourselves to others, to evaluate ourselves against

other people. We may categorize ourselves based on our careers or on the type of people that we wish to be. The categorization forms a narrative that defines who we are.

2.1.4 Self-Image, Self-esteem, Ideal-Self

Carl Rogers, the American psychologist, believed that the self has three different components: self-image, which is the view we have of ourselves, occupation, self-esteem, which corresponds to how much value we place on ourselves, and the ideal-self or what we wish to be (Rogers, 1959).

The three components defined by Rogers make up the personal self. In contrast, Social Identity Theory (Turner and Tajfel, 1986) places the construct of the self in the social setting. According to Social Identity Theory, the self consists of two parts: personal identity, or the things that are unique to each person, such as personality traits, and social identity, which includes the groups that we belong to in our community (Turner and Tajfel, 1986). Thus, we categorize ourselves personally and socially, in a three-step process that consists of self-categorizing, identification, and social comparison (Turner and Tajfel, 1986). We use social categories like race, nationality, and occupation, to categorize ourselves and others. Assigning people to categories tells us something about them, by defining them a priori. Without knowing them, we already have a categorical term for them (Hoggs, 2016).

Identification follows the categorization process when we adopt the group identity of the category. I.e., if we categorize ourselves as students, the chances are that eventually we will assume the identity of students, act as students, and behave like ones, conforming to the norms of the group. The process of identification is emotionally significant because our self-esteem becomes bound with the group, and this generates a sense of belonging (Turner and Tajfel, 1986). In Article II and III, we provide subjects with the perspective of an outgroup, demonstrating how this can impact their attitude towards that group.

The final step of establishing a social identity is social comparison. After we categorize ourselves and identify with a group, we eventually compare ourselves to other groups and compare other groups to each other. Humans tend to equate themselves to others, consciously and subconsciously, and the reason we do this is to maintain our self-esteem (Wood and Wilson, 2003). We want to compare ourselves to other groups in a favorable way. Understanding this process is critical to understanding prejudice. Once two groups identify themselves as separate and rival, they start to compete in order to maintain their self-esteem. This mental process formulates our social identity (Turner and Tajfel, 1986).

The construct of the self is very elusive (Table 2.1). Between the rejection of its existence (Hood, 2013) and the idea that it is stable (Diehl, Jacobs, and Hastings, 2006), the notion of selfhood as a fluid construct is created,

maintained, and transformed by context (Baumeister, 1996). What would be the impact of a reality in which people may be able to experience events from the perspective of different groups, and even from the first-person perspective of a different body?

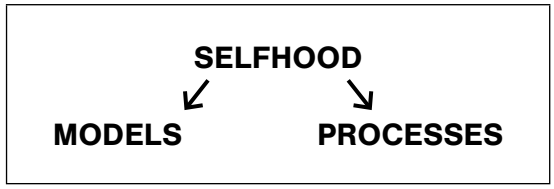

Figure 2.2: Selfhood is a complex and fluid construct

2.2 Self and Technology

In the previous section, we looked at what it means to have a self and be a self. We discussed the several conceptualizations and theoretical frameworks used to constitute selfhood. But what about technology? So many of our interactions with technology have a profound impact on shaping our behavior. The human senses mediate between the physical world and the brain. They are the only source of information for the brain to know anything about the world (Frolov et al., 2019). These biological sensors translate light, sound, touch, pressure, acceleration, and heat into electro-chemical signals that travel via the neural system to the brain. The robustness of the senses and their consistency with object behavior and real-world interactions wire our brain to construct a stable image of the world and an efficient predictive model to operate in it. For example, a newborn moves their hands randomly, hitting a bell in a mobile hanging above them. Initially, they do not know that their hands belong to them, yet thanks to the constant feedback of sound, vision, touch, and proprioception, they gradually develop a sense of body ownership. Our ability to operate in the world relies on a perception-action loop (Gaussier, Moga, Quoy, and Banquet, 1998). The perception-action cycle is the continuous flow of information and action between the brain and the world around it. This cycle consists of the following steps: sense, predict, act, adjust. The perception-action cycle is a feedback loop that helps us to build an understanding of how the world works. But what happens when technology disrupts this loop?

The human sensorium has always been mediated. However, over the past few decades, technology has been amplifying, shielding, channeling, simulating, and imitating our sensorium to the point that it is more mediated than ever before (Hayles, 2008). Since the ancient reflecting surfaces, to advanced information and communication technologies (ICT), the interaction between the self and technology has intertwined selfhood and technology

in a way that begs the questions: what is an identifiable self that emerges through technology? How is advancing technology reshaping private and social identity within society? How do individuals define and navigate their identity within an online culture? What factors influence the evolution of online identity? What are the risks and benefits of life online? What are the ethical and legal implications of virtual embodiment experiences? How does monitoring behavior in virtual worlds affect human meaning and identity development? What various strategies or techniques do individuals use when presenting themselves to others in VR compared to real-life? How will virtual personal and professional relationships affect real-life relationships and vice versa? How is a political and cultural identity defined and navigated within a technological society? Where does the machine end, and the person begin? What is the future relationship between technology and identity? Answering all these questions is beyond the scope of this thesis; however, by voicing these concerns and challenges, I map the context in which my research aims to contribute.

2.3 The Other Self

In her article, "Self, Other and Other-Self" (2011), American scholar Sami Schalk explores the effects of mass-media on contemporary consciousness, identity, and self/other relationships. Schalk proposes an approach to the self/other binary that opens up the possibilities for relations between individuals by including a third term – the other-self. The other-self allows for a fluid, contextualized understanding of the self in a spectrum of relatedness to others in any given moment. For example, the identity one constructs on social media or in other virtual environments is a digitally designed self, created by the user. These extensions of 'who I am' are external to one's immediate experience, and they introduce a relationship with an 'other' that is simultaneously a self. In Article V and Art project III, I devised an experience in which participants get to meet themselves in VR. The experience is fundamentally different from looking into the mirror or watching a video of oneself. In this experience, you get to share a space with your hyper-realistic avatar, coupled with a tactile illusion of holding hands with your-self. This will be described in chapter 6.

2.4 Virtual Embodiment

Owning a body is a complex integration between the body's physical presence and its neural map in the brain. According to Kilteny and Slater (2012), embodiment has three aspects: self-location – knowing where the body is,

agency – the ability to tell the body what to do, and body ownership – the feeling that the body belongs to oneself.

Self-location

Self-location is the ability to understand the positioning of one's body. It consists of identifying the whereabouts of one's body parts in space and in relation to the body itself. This ability is achieved by sensorimotor integration – sight, sound, touch, and movement. Our proprioception and kinesthesia (terms describing the sense of self-movement and body position) are internal neural signals that tell the brain where the body is and indicate its movement. Self-location helps us to accurately maneuver in the world, interact with objects, and avoid obstacles.

Agency

Agency, in the field of cognitive sciences, is the ability to make a voluntary decision for the body to move according to the will of its owner (Nellhaus, 2015; Himmelreich, 2015). From performing basic tasks to avoiding danger, human motoric abilities are incredibly versatile, with infinite ways of responding to external stimulation or internal urges. The feedback loop here is crucial, i.e., the process of making a decision to move a limb, receiving kinesthetic signals of its movement, seeing it move, and feeling the objects it might be touching.

Body Ownership

The sense of body ownership is a series of complex perceptions that result from multisensory body-related signals. This means that the sum of multiple sources of sensory input are integrated into a single sense that "this is my body. I am this body."

The tactile input from the skin correlates with a sensory map in the brain that locates the touch to the geography and topography of the body. Visual-motor contingency helps negotiate the relationship of this body in the physical context it is placed. Most of this sensory input is processed on an unconscious level. Moreover, the habituation of much of this sensory input is necessary to prevent sensory overload (Harricharan, 2017). This implies that body ownership is not a binary state but a continuum. One does not need to suffer from a pathology such as derealization (A dissociative disorder that consists of persistent or recurrent feelings of being detached from one's body or mental processes) (Coons, 1994) or depersonalization (a pathology of feeling disconnected or detached from one's self) (Coons, 1994) to be disembodied – it is a normal continuum.

Another layer of understanding embodiment is that our body is simultaneously the subject and object of intentionality (Slateman and Widdershoven, 2015). The body experiences things in the world, and at the same time, it is experienced as a thing in the world. In essence, I argue that we

contain both a first-person perspective (1PP) and a third-person perspective (3PP). To explore this internal and external experience of the body, I will describe two key terms: body image and body schema (De Vignemont, 2010). Body image is a person's perception of their physical self and the thoughts and feelings that result from this perception. Body schema represents the position and arrangement of the body as a three-dimensional object in space. It is a combination of tactile, visual, and proprioceptive information that contributes to the representation of the limbs in space.

In February 1998, Matthew Botvinick and Johnathan Cohen published their seminal Rubber Hand Illusion study in the journal Nature (Botvinick and Cohen, 1998). The illusion is based on having a participant place their hands on a table while one hand is obscured and placed slightly to the side. A rubber hand is placed instead of where the hidden hand should have been (in front of the participant, next to the uncovered hand). The experimenter then simultaneously strokes both the rubber hand and the corresponding parts of the covered, real hand. The study showed that it takes as little as thirty seconds for participants to feel that they own the rubber hand as if it was their own, thus demonstrating that the representation of the body in the brain is very flexible.

The work of Botvinick and Cohen paved the way for the application of virtual embodiment, which is taking the rubber hand illusion into a full-body 1PP representation in virtual reality (Yee and Bailenson, 2006). With a full-body tracking suit, it is possible to put people in the body of an 'other,' inducing the illusion that the virtual body is their own (e.g., Blanke et al., 2015). When participants look down at themselves or into a virtual mirror, instead of their own physical body, they see a virtual body that moves synchronously with their own body movements. This virtual body may contrast their real, physical appearance in terms of age, gender, or race. The experience of such virtual self-transformations has a profound psychological impact (Won et al., 2015).

The first to experiment with virtual embodiment, in the 1980s, was visionary and entrepreneur Jaron Lanier. His experimental exploration, dubbed The Study of Homuncular Flexibility, explored the human ability to inhabit novel avatars. For example, he explored unusual limb placements and designed a detailed experience of how a two-armed human might control a six-armed lobster avatar (Lanier, 2016).

Since the late '90s, virtual embodiment has been explored extensively. Slater and Usoh (1992) focused on the impact of virtual embodiment and its potential for cognitive and behavioral transformation. In 2007, Jeremy Bailenson introduced the idea of the 'Proteus-Effect' (the tendency for people to be affected by their digital representations), which is concerned with how body-types influence behavior.

Among the virtual embodiment effects that have been studied are age, gender, and race (Peck, 2018). Banakou and Slater (2013) have shown that virtually embodying participants in a child's body affected their size estimation

(Banakou and Slater, 2013). In their study of racial stereotypes, Konstantina Kilteni showed that being embodied in a dark-skinned body dressed in "cool" clothes results in high drumming skills compared to being embodied in a white-skinned professionally dressed student. In another experiment, white participants who embodied black bodies reduced their racial biases towards black people (Peck, Seinfeld, Aglioti, and Slater, 2013), and another study showed that being embodied in the body of a superhero induced pro-social behavior (Resenbgerg and Bailenson, 2012).

Virtual embodiment can be used to study the psychological and neural correlations of various scenarios that are impossible in the real world, such as gender or age switching. Thus far, full-body ownership illusions have been implemented by using real-time body tracking and avatars based on computer-generated imagery (CGI). In publication IV and Art Project II, I propose an alternative technique for inducing perceived ownership over a (photorealistic) virtual body using a 180° stereoscopic video, synchronous touch, and narration. I describe the technical aspects of this novel technique, present an example of its implementation as part of a science-art project that enables participants to experience virtual bodies of different ages, and describe the results of an experimental evaluation study based on this experience. Consistent with previous virtual embodiment studies using CGI-based techniques, we found that participants accepted a photorealistic virtual body as their own, irrespective of its appearance. This was indicated by similar ratings of body ownership strength for a virtual body of a child versus that of an adult. We further show that this novel technique can alter participants' cognition to comply with the characteristics of their virtual bodies. Specifically, young-adult participants embodied in the virtual body of a child significantly overestimated the duration of the VR experience compared to a control group that embodied a virtual body of their own age. This finding corresponds to chronological age differences in time estimations and extends previous research on virtual child-embodiment (Banakou et al.,2013). Overall, these findings provide initial evidence for the potential of this new technique to create photorealistic embodiment experiences with comparable psychological effects to those found using CGI-based techniques while reducing the costs and technical complexity in the production and application of virtual body ownership illusions.

2.5 VR and Empathy

Empathy is the mental ability to bridge the subjective feeling of an individual towards someone else (Ellioth, Bohart, Watson, and Greenberg, 2011). This ability allows one person to understand another person's mental and emotional state and how to respond to it effectively. With this ability, one can

see another's emotional pain and feel it as if it was their own (Moriguchi et al., 2007). Moreover, this phenomenon is not restricted to the mental domain. Pain empathy is when a person receives cues that another person is in physical pain. At that moment, neural pain circuits within the brain of the observer are activated (Baird, Scheffer, and Wilson, 2011). Thus, if one can feel another's personal mental and physical pain, it is evident that the self and the other are not experienced only as external objects. Psychology uses the measure of 'self-other merge' to evaluate degrees of empathy (Batson et al., 1997). Since so many of our interactions are mediated, could empathy be activated via mediated interactions such as text, audio, pictures, films, or virtual reality?

The term empathy is quite often vaguely described (Gerdes, Segal, Lietz, 2010). Within the field of cognitive science, it is generally defined as the potential to recognize and feel the distress of others (Cuff, Brown, Taylor, Howat, 2014). In daily life, the term is regularly used interchangeably with concepts such as sympathy and compassion, and it is seen as a positive driver for pro-social behavior, decreased stereotyping, and reduced discrimination of outgroups. The idea that VR could offer a compelling new medium for enhancing empathy and pro-social behavior has become common among many early adopters of – mostly documentary – VR projects (e.g., Clouds Over Sidra, 2015). Chris Milk, an American entrepreneur and immersive artist, has declared VR to be "the ultimate empathy machine" (Milk, 2015 TED talk). This claim suggests that by giving participants an experience of presence and the sensation of being spatially transported into the center of a scene, VR can elicit in the participants a more significant experience of identification and empathy with the co-present humans than traditional formats.[2] However, without empirically studying the underlying mechanisms of empathy, specifically in the context of VR, Milk's claim remains an over-hyped techno-fix.

In Article I, I explored empathy in the context of private identity. In the VR experimental design, participants experienced sitting in a room in front of a person who shared a painful, personal story. We devised a media-comparison study, in which we assessed the impact of VR by examining physiological and subjective indicators of empathy. Furthermore, we investigated the role of social presence (i.e., the experience of being there with real others) in modulating the empathic responses. This empathy-eliciting video was presented either in a VR headset or on a computer screen. We recorded autonomic and facial responses from the target in the video and the participants who viewed the video. We found that the VR condition enhanced

2 The idea of using novel technology and art to drive change in social attitudes is not a new one. Similar claims have been made about conventional 2D films. The phrase "empathy machine" was first used by the film critic Roger Ebert to explain the power of cinema "something that allows us windows into lives we wouldn't otherwise know a thing about and forces us not to remain passive observers but become active participants in the emotions that unfold there" (Ebert, 1990)

the motivational component of empathy in viewers. That is, the empathic care for the target's well-being and the wish to alleviate her suffering was greater in the VR condition. In addition, participants in the VR condition exhibited higher levels of facial synchrony with the target, indicative of social connection. Finally, the VR condition elicited higher levels of social presence, which mediated the effects of VR on empathic care as well as on facial synchrony with the target. The current study highlights the potential of VR, compared to standard video, to elicit social connectedness and a caring motivation to help and console others. Our findings imply that VR has a unique potential to motivate empathy in situations where face to face encounters are not possible.

In Articles II and III, I explored empathy in the context of social identity. I present an experimental study, conducted in the context of the Israeli-Palestinian conflict, that examined the effect of immersive 360° video on inducing a more critical perception of the ingroup's actions in the conflict.

VR's capacity to drive social change is related to a well-trodden path concerning the role of artwork and media plays as a social change driver. However, the application of nonfiction VR as a method of producing empathy has been criticized on a number of grounds. One objection was raised by Kate Nash, who claims that the concept of using VR to produce empathy promotes a "mistaken distance" between problem and viewer. Nash argues that at its best, nonfiction VR can offer a superficial empathy (Nash, 2017). She further contends that in suggesting that such encounters can provide a deep understanding of the rapports of others, nonfiction VR may trivialize the suffering of others while fetishizing our personal responses to their struggling. Moreover, Paul Bloom shows that the construct of empathy itself has serious limitations, particularly when it comes to moral decision-making in the modern world (Bloom, 2017). With this critique in mind, I used VR documentary storytelling in Art Project I, reported here. Although the context of the project refers to the Israeli Palestinian conflict, I deliberately sought to direct the interview of the characters to personal identity issues, to eliminate stereotypical victim/victimizer perspectives.

The consideration of nonfiction VR as a driver for empathy encounters a significant obstacle in the challenge of measuring empathy through implicit tasks. My hope is that the method and findings of Article I, in which I provide evidence that this method elicits empathetic care when shooting a scene as specified in the article, will help creators use VR to illicit empathy in their fiction and nonfiction productions.

2.6 Storytelling

Forming a connection with another individual is one of the highest forms of social interactions (Lofland, 1982). One of the most significant vehicles for this is storytelling (Bove and Tryon, 2018; Lisenbee and Ford, 2017). When telling a story, mental and emotional constructs transfer from one person to the other. It enables people to be in sync with each other (Frude and Killick, 2011). Stories are a form of transmitting information (Gershon and Page, 2001). Story is the process of using narratives to communicate something to the audience. Some stories are factual, and some are embellished or improvised in order to explain the core message better (Tanenbaum, 2014). They are vehicles of meaning for anything between sharing experiences, inspire action, communicate values, teaching, or entertaining. In-person storytelling notwithstanding, every communication technology impacts storytelling (Salpeter, 2005).

2.7 VR Storytelling

The history of storytelling is intertwined with technology (Yılmaz, 2019). The invention of each information communication technology (ICT) has had a profound impact on how people create, store, and share stories. Each communication technology has its distinct qualities and features. These qualities directly influence the way a narrative is expressed and affect the way this narrative is consumed. Ultimately, every technology develops a unique grammar, conveying a cyclical relationship between form and content with profound emotional, cognitive, and socio-political implications (O'keeffe, 2006).

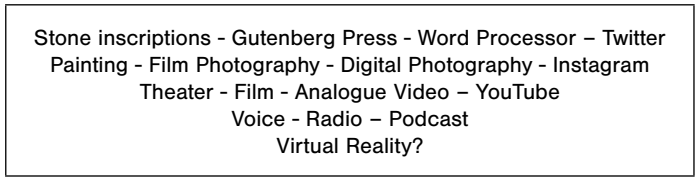

Figure 2.3: The evolution of media

Where does this leave VR? Where does VR fit in the coevolution of storytelling and technology? Historically, VR has had three waves: during the 1960s, the 1990s, and the mid-2010s (Mazuryk and Gervautz, 1996). However, it wasn't until 2012, when a small company in Silicon Valley called Oculus had released a developer kit head-mounted-display, and for the first time, a viable consumer VR system reached the market. Three years later, in 2015, Facebook

bought Oculus, in a move that signaled an essential milestone in the industry's adoption of the technology, indicating VR's potential to impact the fabric of our digital life. The industry sought out uses for VR technology. Naturally, like in previous introductions of new ICT, the creative community explored what VR could bring into storytelling. With decades of science-fiction works describing participants immersed in fantastic worlds, being who they want to be, escaping their mundane physical life beg the question, VR had some high expectations to fulfill.

In 2016, I worked as a creative director for an Israeli startup company ambitious to become 'the Netflix of VR.' There, I was responsible for conceiving and producing content. This unique experimental lab allowed me to explore VR storytelling, understand its grammar, devise different vocabulary, and create engaging content. Cinema was a natural point of departure for creating VR content. In over 130 years, cinema has evolved into an elaborate language extremely beneficial for telling stories that impact our lives and shaped modern culture as we know it (Ross, 2006).

At first glance, VR and cinema have a lot in common:

- **Production**: In both media, content can be captured with digital cameras or produced using computer graphics.
- **Camera techniques**: Theoretically, it is possible to use similar camera techniques such as handheld, traveling shots, and point of view.
- **Postproduction**: It is possible to use similar production techniques such as editing, special effects, color correction, sound-design.
- **Delivery**: Content can be delivered to digital devices with internal storage for playing back the content.

However, in contrast to films (and other 2D display technologies), in which the visual information is presented in a frame, in an immersive video (such as 360° or, in our case, 180°),[3] the visual field changes in synch with the participant's head movements. This means that although one can apply cinematic techniques to VR content, in reality, these techniques hold a completely different perceptual and semantic meaning. VR's key value lies in its unique capacity to elicit the sense of presence due to the sensorimotor contingency. Moreover, In the case of a virtual scene depicting a social interaction, VR elicits a sense of social co-presence. In cinema, a close up is a technique to emphasize details (of a character, an object, or an interaction); in VR, a 'close-up' means literally placing the character or an object extremely close to the participants. In cinema, traveling shots are an effective technique to convey dynamic motion. It could follow a character or may be used for

3 Immersive video can be regarded as a specific subset of immersive VR, as it includes sensorimotor contingencies (Slater, 2009), one of the most important principles of VR. For further discussion see Ch.3 Section 3.4)

revealing visual information over time. In VR, traveling shots cause nausea since they break the visual-motor synchronicity. Directing attention must be designed carefully, since the participants may look to any direction they wish.

In the following table (Table 2.1), I specify what visual language I used in each project and its semantic meaning.

Table 2.1: Visual language of each project and its semantic meanging

Project	Visual Technique	Semantic meaning
Article I: Exposure to social suffering in VR boosts compassion and facial synchrony	Fixed camera simulating 1PP Face to face encounter (No Virtual Embodiment). Subject looking into camera lens.	Simulating the interpersonal distance between close people
Art Project I: Visitors	Fixed camera simulating 1PP Face to face encounter (No Virtual Embodiment). Subject looking into camera lens.	Simulating the interpersonal distance between close people
Article II & III: The Enemy's Gaze & VR based Conflict resolution	Fixed camera, simulating a 2PP Over the shoulder camera angle	Simulating the perspective of each group
Article IV: A virtual embodiment using 180º Stereoscopic Video & Self Study	Fixed camera rig, simulating a 1PP of a character with Virtual Embodiment	Being in the body of the protagonist
Article V and Art Project III: Self-Study	Fixed camera rig, simulating a 1PP of a one-self with Virtual Embodiment	Being present in the virtual space with one's own body, simulating the interpersonal distance between close friends, which in this case is you.

Table 2.2: Technique and Semantics comparison between VR and cinema

Technique	Medium	
	Cinema	Virtual Reality
Close-up	Focused attention on detail. Effective for emotional impact.	Places an object or a person close to you. It complies with conventions of interpersonal distance.
Editing	An effective way to cut between scenes; advances a story and creates a semantic meaning.	Breaks the sense-of-presence, "teleports" the participant to different scenes
Traveling shot	A means to make a shot dynamic. May function as a POV shot, helping us "be" with the protagonist on his journey.	Breaks the sensorimotor contingency, and the sense of presence. May work in interactive CGI experiences with a treadmill.
Point of view (POV)	Represents the perspective of characters.	VR is primarily made of point-of-view shots whether the viewer is explicitly part of the narrative structure or a fly on the wall.
Sound design	Useful means to construct the soundscape of the scene. It includes dialogue, follies, ambient, and music.	Useful means to construct the soundscape of the scene. It includes dialogue, follies, ambient, and music. Sound needs to be edited as ambisonic spatial sound to correspond to the movement of the viewers.
Depth-of-field	Depth-of-field is an optical phenomenon – when looking at a close object, the background is perceived as blurry. It is a technique used to draw the attention of the viewer. The attention of the viewer will automatically shift to the focused part of the frame.	Since in VR, the viewer is free to direct their gaze in any direction, this naturally occurring phenomenon cannot be predetermined.
Lighting	Lighting is a significant element for setting the design and atmosphere of a scene	In a 360º video shoot, placing lighting in the scene is very limited since it's impossible to conceal the lamps and rigs. However, In a CGI scene, the lighting artist can illuminate the scene any way they like.
Framing	Creating frame composition is an important means to control the visual information. It could be utilized for creating esthetic, dramatic, and narrative meaning. Moreover, this is also a means to drive attention to key elements the director wants to highlight.	There is no framing in VR. The viewer is placed within the entire scene and is free to look at any direction they desire. There is no control of what they're looking at or what they notice.
Actors	In cinema, actors perform with camera angles in mind. They can use nuances since close-up shots are common.	Acting in a 360º shoot, resembles theater acting more than cinema. Scenes are mostly shot as single shots, with few cuts. The distance from the camera suggests less nuanced acting.

If VR cannot use cinematic grammar to the same effect, then to what other art form does it relate? With VR's capability to place the viewer within a space, and elicit the sense of social presence, it turns out that although VR is a novel digital technology, essentially, it has a lot in common with theater, specifically, with immersive theater. Immersive theatre is a form of theater that seeks to challenge the audience-performer relationship by removing the stage and immersing audiences in the performance itself (White, 2012). Often, this is accomplished by using a specific location and breaking the fourth wall (Quinlan, 2009).

Table 2.3: Elements and Semantics comparing VR and Immersive Theater

Technique	Medium	
	Immersive Theater	Virtual Reality
Space	Often located in a specific location with contextual meaning for the piece.	As in theater, a VR scene can be contextualized in an actual place, the sense of being present in the space holds the potential for the environment to be a dramatic parameter in itself. As opposed to a site-specific theater performance, since VR has the flexibility of editing, space can be used as an evolving parameter.
Sound	Spatialized sound, multi-channel sound system, actors surrounding participants	Spatialized sound, multi-channel sound system, actors surrounding participants
Attention	Action, Light and Sound used to draw attention	Action, Light and Sound used to draw attention
Narrative	Since direction attention is a challenge, immersive theater often uses non-linear storylines	Since direction attention is a challenge, VR often uses non-linear storylines
Acting	Non edited acting	Mostly non-edited acting
Live	Sense of live event plays an essential role in the theater	Currently, live VR streaming technology is not widely adopted

Examples of immersive theater projects

Sleep No More (Punchdrunk, 2011)
Participants enter a building in which they are free to roam in any way they want. They encounter scenes that accumulate to a non-linear experience without a start-middle or end.

Then She Fell (Third Rail Projects, 2016)
Fifteen audience members per performance explore a dreamscape where every alcove, corner, and corridor has been transformed into a designed world. Inspired by the life and writings of Lewis Carroll, it offers an Alice-like experience for audience members as they explore the rooms, often by themselves, in order to discover hidden scenes, encounter performers one-on-one, unearth clues that illuminate a shrouded history, and use skeleton keys to gain access to guarded secrets.

Inside the Wild Heart (Andressa Furletti and Debora Balardini, 2018)
This theatrical experience is based on the works of Brazilian writer Clarice Lispector. The show transports you directly inside Lispector's heart, creating an experience that encourages audiences to engage with literature on a sensory level.

In sum, VR poses challenges to traditional cinematic storytelling. Creating a storyline with central characters and key events in VR does not meet the challenge of participants' freedom to direct their gaze freely, as they may miss the event the director wants to highlight. In contrast, VR uses immersive scenarios to tell stories in ways similar to theater, particularly immersive theater, utilizing means such as non-linear stories, multisensory installation, and proximity (or the illusion of proximity) to actors.

2.8 Virtual embodiment storytelling

First-person storytelling is perhaps the most fundamental way a person shares an experience with another individual or a group. Virtual embodiment is, by definition, the ultimate first-person perspective (1PP) experience. It is a unique type of media experience that induces the illusion of owning a virtual body. However, storytelling techniques from a 1PP have a tradition and history in various media. The following table set an overview of milestone projects using 1PP storytelling and the respective mechanism used:

Table 2.4: First-person perspective in different media

Title	Author/ Director	Year	Mechanism
Literature			
A Rose for Emily	William Faulkner	1930	Written in the first person
Cheaper by the Dozen	Frank B. Gilbreth Jr. and Ernestine Gilbreth Carey	1948	Written in the first person
Man Plus	Frederik Pohl	1976	Written in the first person
The Virgin Suicides	Jeffrey Eugenides	1993	Written in the first-person plural
Cinema			
The Lady in Lake	Robert Montgomery	1947	• 1PP, no body • Eye contact, Social acknowledgment
Being John Malkovich	Spike Jonze	2000	• 1PP, no body • Eye contact, Social acknowledgment
American Beauty	Sam Mendes	2000	Voice Over
Hardcore Henry	Ilya Naishuller	2015	• 1PP, no body • Eye contact, Social acknowledgment
Computer Games			
Spasm	Jim Bowery	1974	• 1st person Shooter • Interactive
SubRoc-3D	Sega	1982	• 1st person Shooter • Interactive
Wolfenstein 3D	id Software	1992	• 1st person Shooter • Interactive
DOOM	id Software	1993	• 1st person Shooter • Interactive
Virtual Reality			
I Philip	Pierre Zandrowicz	2016	• 1PP, no body • Eye contact, Social acknowledgment
First Person	Christina Hella	2018	• 1PP, no body • Eye contact, Social acknowledgment
Library of Ourselves	Be Another Lab	2015	• 1PP, with body • Touch
Embodiment and Voice	Banakou, Domna, and Mel Slater "Embodiment in a Virtual Body That Speaks Produces Agency over the Speaking but Does Not Necessarily Influence Subsequent Real Speaking."	2017	• Full body tracking 1PP with body • Reflective virtual mirror • Vibrating motor Note: not used to tell a story but provides a unique modality that may be used for story-telling

One commonality to all these genres using the 1PP is the apparent attempt to immerse the listener, viewer, or gamer in the story or the action. However, it is important to note that there is an inherent conflict between agency and storytelling. The described 1PP narrative computer games in figure 2.2 are valuable examples of how storytelling and interactivity may work together.

So, where does VR fit into the evolution of media and technology? Previously in this chapter, I've discussed the notion of presence and the application of virtual embodiment. It seems that VR is the ultimate 1PP medium, with great potential for placing the viewer in the shoes of the protagonist, thus taking 1PP storytelling to a different level. The outcome of this dissertation will, hopefully, provide both insights and methods for VR and embodied storytelling.

2.9 VR for Social Change

VR introduces ecological validity or "brings the world into the lab." Interestingly, VR could also potentially be used for the reverse process, namely, for creating an intervention as a tool for social change and personal improvement or therapy. In recent years, neuroscientists and behavioral psychologists have provided empirical evidence that VR experiences can influence the way people behave in real life (Cakiroglu and Goekoglu, 2019; Lavoie and King, 2020). It has been shown that participants who were virtually embodied as an avatar in a VR environment were more likely to develop a strong sense of empathy towards their virtual avatar and change their attitude towards the group the avatar represents, in some cases to the point of appropriating the behavior and perception of the avatar (Slater and Sanchez-Vives, 2014; Banakou, Hanumanthu, and Slater, 2016). Another study demonstrates that participants embodied in the body of a superhero avatar were more likely to show altruistic behavior (Rosenberg, Baughman, and Bailenson, 2013). In addition, participants embodied in the body of an avatar of a person of color showed reduced prejudice against that particular racial group (Peck, 2013).

These findings raise the question: To what extent can virtual embodiment interventions become a social tool for social change? To address this question, I take a broader look at the relationship between science, art, technology, and society. Every technology that disrupts our lives has a tremendous impact on our social structures and private lives, to the extent that it can help redefine what it means to be human (More, 2013). One of the processes that I wish to highlight is how technology becomes a language, then part of our psychology, and finally, how it is conceptualized and becomes a philosophy. In cinema, which is considered the leading art form of the 20th century (Nowell-Smith, 1996), there are many technologies involved in materializing it as an art form. From the development of the optical lens to celluloid film and to projection

technologies, cinema evolved and expanded its techniques to gradually form a new language (Nowell-Smith, 1996). This visual language, which is nowadays taken for granted, has become an integral part of how we produce and share ideas, entertain, and teach. Cinema has become a dominant reality in modern society. Ultimately, it has become an essential part of our psychology and a defining medium for political and social structures (e.g., Ross, 2006).

In Article II and III, I demonstrate the capacity of a VR intervention to increase empathy towards outgroups. In Art project I (elaborated in chapter 5), I describe how art projects using VR can reach large audiences and potentially create significant impact.

So, what can we expect from VR and virtual embodiment? Could VR and virtual embodiment eventually establish their own unique language and grammar? In a possible future, could our experience with VR be that of active participants in stories, becoming different characters, and experiencing their world first-hand, within a new social and personal field of possibilities? The challenge will be to have scientists, content creators, and policymakers work together to explore the potential of immersive media to be an integrated tool for bridging groups and individuals together. It is possible that in the same way that print, cinema, and digital information technologies have all played a central role as political catalysts, VR will be a powerful new tool for building trust in the societal realm in ways not possible before (Madary, 2016).

3. METHODS

3.1 VR – A behavioral lab

Throughout history, there has been a close interplay between technology and science, or apparatus and knowledge. Cyclically, scientific discoveries led to technological advancements, which in turn served as an essential enabler for scientific research (Stokes, 2011). This relationship is not only instrumental; it has roots in how humans and technology co-evolved. More than something that humans make to optimize their activities, technology is a mode of being (Heidegger, 1954), or of revealing. It reveals and uncovers the secrets of nature, processes, places, constructs, and structures.

For example, the development of the telescope (Figure 3.1) has revealed where we are in the universe, and it helped advance the science of astronomy. The microscope has shown what we are made of and led to significant advancement in biology and medicine.

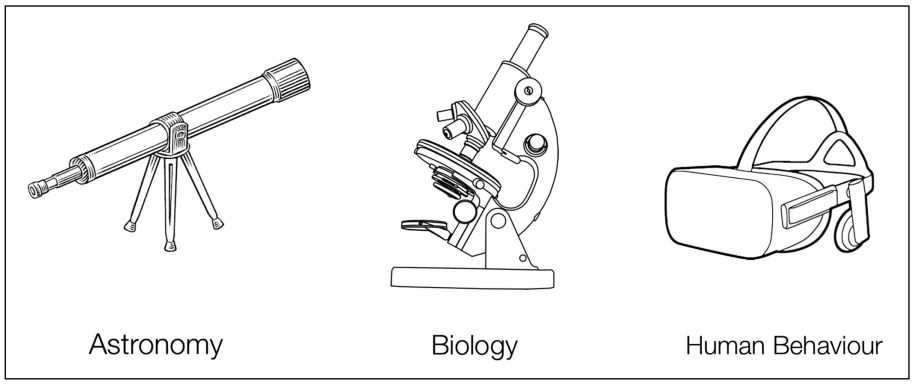

Figure 3.1: The relationship between technology and science

As opposed to most imaging technologies, such as digital sensors and displays, image processing, and image recognition, VR is unique in its relationship with the human body. VR's head-mounted display feeds information received from tracking sensors to the moving image rendered on the display, similar to the way the brain perceives the contingency of motor and visual information. This sensorimotor contingency creates a sense of presence and is responsible for the illusion of being in a different world or virtual reality. This feature provides VR with two unique benefits for research: ecological validity and access to spatial data.

3.2 Ecological Validity

At the heart of VR technology lies a new type of relationship between humans and perceptual technologies. VR technology introduces visuomotor contingencies that result in the cognitive illusion of being present in a different reality. This, of itself, represents a significant breakthrough for researchers by bringing ecological validity into the lab, thus adding another level of validity to the internal validity of controlled experiments. Studying human behavior in a laboratory is challenging. In behavioral research, it is notoriously difficult to study authentic human behavior in a controlled setting. Using VR makes it possible to place a participant in a controlled and repeatable scenario and measure their response to the stimulation (Blascovich et al., 2002). This allows the researcher to bring the world into the lab (Loomis, 1999). Previous attempts to achieve ecological validity have been made using films (Hasson et al., 2008). The main difference between film and VR is that VR provides a sense of presence, which is an entirely different scale of experience, from a perceptual perspective, because it can elicit the illusion of being within the scenario, as opposed to looking at it via a screen.

3.3 Spatial Data

Beyond its ecological and internal validity, VR provides another methodological opportunity. It enables the collection of implicit data by tracking participant movements through motion sensors. VR devices track head orientation, and most devices also track head position. Furthermore, new devices include high precision eye-tracking sensors, thus making it possible to identify observation patterns. Full-body tracking technologies can measure movement and micro gestures and analyze in great detail the correlation between movement, contextual variables, and response times.

3.4 360º and 180º Stereoscopic Video

The experiments and art projects presented here are all based on 180º and 360º stereoscopic video, also referred to as immersive video. Although the classification of immersive video as VR is currently under debate (Paíno, 2019), it still makes sense to explore the advantages and disadvantages of using 360º stereoscopic video for research.

As mentioned previously, in the heart of VR technology lays the sensorimotor contingency (Slater, 2009). Our vision is termed 'active vision' because it is always coupled with movement. Even while lying still, constant ocular movement keeps altering the visual field, transmitting dynamic visual

information to the brain. The 360° video technology, developed in 2014, is a combination of hardware and software for both production and experience/display. The hardware comprises rigs holding two to twenty-five cameras in a spherical formation (Figure 3.1). The software stitches the multiple images into an equirectangular frame, which is a rectangular form containing distorted information of the image once projected on a sphere, resulting in a 360° environment with the participant in its center. Thus, the participants can choose where to look while the video is playing.

Figure 3.2: Left, 2014, 10 GoPro 360° camera rig. Right: 2016, Unibody Nokia OZO 360° camera

The motion tracking in the display devices is limited to head orientation of three degrees of freedom (3 DOF) that includes yaw, pitch, and roll. In contrast, full-motion tracking suites enable a broader range of motion (6 DOF), rendering it significantly more flexible, especially considering the possibility of roaming computer-generated environments. However, since the 3 DOF provided by the 360° stereoscopic video simulates a stationary situation, the experience results in a sensorimotor contingency that generates a sense of presence. Thus, when applied properly (e.g., stationary camera) it makes 360° and 180° stereoscopic video an important subset of the characteristics of VR. Immersive video (either 360° or 180°) should be regarded as a specific subset of immersive VR since it provides sensorimotor contingencies, an essential principle of VR. Moreover, as I demonstrate in Article IV, it is also a valid medium for eliciting virtual embodiment.

3.5 Advantages and disadvantages of using 360° and 180° stereoscopic video

Before reviewing the advantages and disadvantages of using 360° or 180° stereoscopic video for behavioral experiments, I will briefly compare computer-generated imagery (CGI) VR to 360° stereoscopic video. In CGI VR, environments and characters are modeled in three-dimensional spaces that are rendered in real-time. The environments, objects, and characters are all calculated and projected as stereoscopic images in the head-mounted-display, in real-time. This makes it possible for participants, who wear sensors that track their movement, to roam the virtual environment, manipulate objects, and, in the case of virtual embodiment, to have full agency over the virtual body, controlling it completely.

I will evaluate the advantages and disadvantages of 360° stereoscopic video with the following parameters: cost, realism, experimental control, and agency.

3.5.1 Cost

Producing a CGI scene requires considerable resources. A typical workflow consists of modeling an environment, modeling characters (body, dress), texturing the elements, lighting, rigging, animating all the moving elements, and finally, coding the interaction. Although there are increasingly available reusable asset libraries, in high-end productions, each phase may require a specialist or an entire team. Since the whole scene is rendered in real-time, it requires a powerful computer to render an entire scene.

In contrast, the production workflow of 360° stereoscopic video is much simpler and cheaper. The process includes three steps: capturing the live scene, stitching the footage, and editing the footage.

3.5.2 Realism

The current state of real-time CGI rendering of a full set of VR characters and environments is only gradually becoming visually realistic. To date, the environments and characters are often perceived as synthetic, subjected to the uncanny valley (Mori, 1970).[4] However, Vinayagamoorthy, have shown that in some interactions, behavioral realism generates a higher level of believability compared to photorealism (Vinayagamoorthy, 2004). 360° stereoscopic video is, by default, photorealistic, depicting actual places and people with all their behavioral nuances within a scene. An important aspect of capturing live action is that it allows us to monitor and study the interaction

4 The uncanny valley is the relationship between the degree of an object's resemblance to a human being and the emotional response to that object.

of the participants with specific people. For example, in Article V, I designed an experiment in which participants meet themselves in VR.

3.5.3 Experimental Control

One significant advantage of using CGI VR in experimental settings is its ability to provide a high degree of experimental control. Controlling variables is an essential component of experimental science, and since all the variables of the scene are constructed and designed from scratch, changing specific parameters is a straightforward process. In contrast, although it is possible to shoot a 360° stereoscopic video scene as many times as needed to vary the critical parameters, the degree of control is still limited compared to CGI. Moreover, CGI offers interactivity, which is not possible in 360° video. The advantage of CGI VR is that it opens possibilities, albeit limited, for human to avatar interaction, object manipulation, and other responses to the participant's actions.

3.5.4 Agency

Because VR elicits a sense of presence that can seemingly transport the viewer to a different place, it's only natural that the viewer would expect to operate in the virtual space as they do in the real world. Thus, having an active body in the virtual space is crucial for a complete experience.

Recall the three components that make up the sense of embodiment presented in Chapter 2: self-location, body ownership, and agency. In Article IV, I elaborate on how to use 180° stereoscopic video to virtually embody a participant in the body of an avatar. The first two components, namely, self-location and body ownership, are satisfied with this technique. However, one notable limitation of using 180° video for VR is that unlike full-body tracking in CGI pipelines, it is unable to generate agency. Since the video is pre-recorded, any movement incongruency between the pre-recorded body and the actual body of the viewer may result in breaking the sense of presence. In order to overcome this obstacle, it is crucial to keep the participant's body positioned identically to the filmed body presented in the HMD. In Art Project III, I have overcame this limitation by introducing a simple mirror game protocol that enables the participant to move their hands while staying in-sync with the pre-recorded virtual body.

3.6 The Open Lab Format

Throughout my career, I have been showing in art galleries, museums, and festivals. As I began my scientific research, I faced the challenge of recruiting participants for experiments. In a very organic process, as scientific knowledge permeated my artistic work, I increasingly focused my interest on the way the

artistic intervention affects participants, and ultimately, I began to gather valuable data during live audience participation events. This is how the Open Lab concept came to be (see Art Projects II and III). In bringing a controlled experiment into the context of the art world, the questions raised in section 1.2 (Artistic Research) are of serious consideration. From an artistic perspective, observing controlled experiments, taking into account and reflecting on their broad social and political context, I found the experience of the actual experimental stimulation to have performative qualities. In 2016, the director of the Print Screen festival, Lior Zalmanson, invited me to participate in the festival. At the time, I was piloting a new technique of virtual embodiment, and I thought that it could be an excellent opportunity to present this as an art-science experiment. The idea was to open an ad-hoc lab during the three-day festival and have the festival audience register for the experiment. On the final day of the festival, we held an open demonstration of the experiment, followed by a talk to explain the various mechanisms behind it. The performance added a significant benefit to the experimental process. Not only did it facilitate participant recruiting (we ran 100 participants in three days), but the demographics of the participants were considerably more heterogeneous than college students, who usually make up the population sample in experimental behavioral research.

Along side these benefits, there was an inherent tension between the artwork that, by its very nature, demands a complex, multilayered expression, and the controlled experiment that requires a well-defined question and a clean design. The attempt to satisfy the two requirements threatens to contaminate both, resulting in superficial artwork and shallow science. If the pitfall is so prominent, what benefits are worth these risks? I will come back to this question in the general discussion and concluding remarks.

4. ART PROJECT I: *VISITORS*

Media Installation, Israel Museum Jerusalem, June 2018-May 2019

Figure 4.1: 'VISITORS,' Israel Museum, installation view

Credit List

Created and Directed by Daniel Landau
Translator and Content development: Samira Saraya
Documentary Researcher: Yair Sugarman
Camera: David Rudoy
Drone Operator: Aviv Kegen
Room Design: Hagar Brotman
Prop-man: Ron Rochman
Industrial Design: Elad Ozeri
Code: Sraya Harif, Eitan Hayak
Translators: Abed Natour,
Software QA: Emil Landau
Production Manager: Shahar Marcus

The members of the Sabateen and Avidan families requested not to be identified by their names.

The installation was funded by the Israel Museum and Actiview LTD.

4.1 Introduction

In the preface, I have described how growing up in the French Hill with the adjacent segregated village of Isawiya had seeded my quest to investigate the self-other gap. The reality in which I grew up marked a paradox in my world view – how can people living so close, live such separate lives? This question was the driving force behind the artistic and scientific works presented here.

In January 2018, I was approached by Israel Museum's Curator, Shir Meller-Yamaguchi, to create an installation for a group exhibition titled "I to Eye, Together or Alone" dealing with the theme of relationships. This open invitation was an occasion to create a piece about two communities that are together-alone.

The opportunity to design a physical installation seemed like a great way to fuse the imaginary and the real. I wanted to create an installation that confronts the separated communities and places them side by side in the same space, allowing them to visit each other's home, meet each other's family members, and hear each other's stories (Figure 4.1).

In preliminary field research, I visited the French Hill and Isawiya, looking for two families willing to participate as the protagonists of the project. Upon my arrival, I discovered a harsh reality of hostility and oppression. It was clear that the circumstances would make it difficult to find willing participants to cooperate in an art project. The daily reality of Isawiya, which includes constant clashes with the border police, arrests, confiscation of land, and house demolitions, left no room for artistic collaboration, particularly not one commissioned by Israel's national museum. Determined to fulfill the concept of the installation, I set out to find two communities in a similar context, whose reality is less distressing. Aware of the 'no-cooperation' policy practiced in the Palestinian Authority, I understood that finding a Palestinian family willing to take part in this project will be extremely challenging. After a few dead-end leads, I was told about Raji Sabatin, a peace activist from the village of Husan located in the Palestinian authority (Figure 1.2), who facilitates Arab-Jewish gatherings. Not long after, I met Sabatin and his family at their home. Thus, I found my protagonists. Next, I set out to find a Jewish family in the adjacent religious settlement of Beitar-Ilit. Here too, I was met with suspicion and very little willingness to consider participating in a project dealing with the Arab neighbors. Eventually, I met the Avidan family, a liberal, religious, Jewish family of Tunisian descent. I began the process of visiting the families, getting to know them, and earning their trust on my own. Here, I was getting in touch with the 'other,' an Arab family, and a religious Jewish family.[5]

5 Video documentation of the exhibition installation: https://vimeo.com/285506574

4.2 A Mixed-Media Installation

Visitors is a mixed-media installation that comprises three main elements: a physical installation, a VR installation, and a single-channel video. Each element provides a different perspective on the gap between the communities. The single-channel video offers a birds-eye perspective, revealing the differences between the architectural fabrics of the Arab village and the Jewish neighborhood; the physical installation portrays the different cultural layers of the two families, and the VR installation provides a window into the intricacies between them.

4.2.1 The Physical Installation

In the physical installation, I wanted to create an environment that fuses the living-rooms of the two families (Figure 4.1). The gallery space was divided into two. In each half, I have created an elaborate, realistic replica of the living-room of its respective family. From the floor tiles to the wallpapers, the furniture, and the pictures on the wall, I constructed exact reproductions based on the 360° videos shot in the families' homes (Figure 4.2). The living-rooms, welcoming spaces of hospitality, acted as cultural capsules. Every object placed there represents layers of cultural identity. The rarity of Israeli Jews and Arabs visiting each other's homes made the museum gallery a place where impossibilities become a speculative reality and a locus of hope. My goal was for the exhibition visitors to discover the many commonalities between the two communities.

Figure 4.2: Top left, Arab family's room Installation view, top right, Arab family's room as captured in the video, bottom left, Jewish family's installation view, bottom right, Jewish family's as captured in the video

4.2.2 The VR Installation

While the physical installation functioned as the cultural context of the work, the heart of the exhibition consisted of meeting the members of the two families via VR. Wearing the VR headsets placed the viewers in the actual living room of one of the families, where they met the family members face-to-face. Following the findings reported in Article I, in which I demonstrate that meeting a person in VR increases the empathetic care for that person significantly compared to 2D video, VR was designated a vital role in this installation. Ultimately, this was the first fruit of combining years of empirical and artistic work into a single project.

In each half 'room' of the physical installation, there were three pedestals, all bearing VR headsets (Figure 4.3) playing the same footage of the room's respective family. The multiple headsets were required in the interest of managing audience traffic. This consideration also determined the length of the VR clips, which were constrained to 3-4 minutes. Finally, the experience was designed to invite the exhibition visitors to sit in the living rooms of the two families and meet their members.

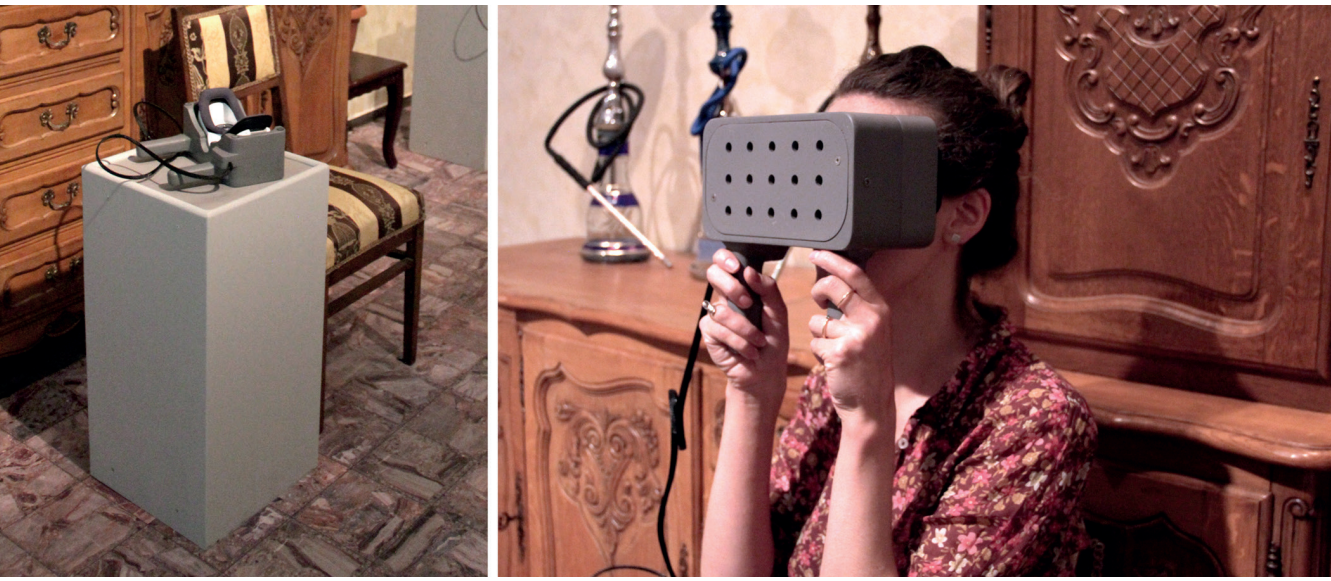

Figure 4.3: I designed a custom contraption covering the headset to meet the demanding wear and tear of numerous visitors in the exhibition

4.2.3 The Single Channel Video

The single-channel video was projected on the wall between the two half-rooms, precisely on the seam. The video is a birds-eye view of the Arab village and the Jewish neighborhood shot from a drone. The footage was edited

in a split-screen composition (Figure 4.4), presenting a unique view of the architecture, spatial structures, and culture of the two communities. The birds-eye perspective provided a layer of abstraction and distancing, while simultaneously hinting at the different ways of life of the two communities.

Figure 4.4: Screengrab of the 'birds-eye view' video projected on the wall between the two living-rooms.

4.3 The VR Content

As described in the previous section, VR introduced the personal layer of the exhibition and allowed visitors to meet the Arab and Jewish families 'in-person.' The content presented in the VR headsets was 360° 3D video POV interviews with the family members. It was designed so that the participants viewing the content in VR would feel as if they were sitting face-to-face with the family member and listening to their story.

To film the different family members, I used the 360° camera, while maintaining the same personal distance I used when shooting the target in Article I. This distance, which is specified in Edward Hall's interpersonal zones (Table 4.1) creates a perceived personal distance for the viewers who met the filmed family members via the VR headsets.

Table 4.1: Edward T. Hall, Interpersonal distance zones

Intimate distance (embracing, touching or whispering)	**Personal distance** (interactions among good friends or family)	**Social distance** (interactions among acquaintances)	**Public distance** (public speaking)
Close phase - less than 1 to 2 cm	Close phase - 46 to 76 cm	Close phase - 1.2 to 2.1 m	Close phase - 3.7 to 7.6 m
Far phase - 15 to 46 cm	Far phase - 76 to 122 cm	Far phase - 2.1 to 3.7 m	Far phase - 7.6 m or more.

The interviews I conducted with the family members were semi-structured. I have prepared four sets of questions (Table 4.2), one for the children and one for the adults, with an adaptation for the Jewish and Arab families. The items were constructed as a gradual inquiry of willingness to get closer to the other community. I was interested in exploring how far each family would be willing to engage with the outgroup (Wang, 2014), and at what point does the wall of mistrust appear.

Table 4.2: Interviews questions

Questions for the Arab children Interviewees	Questions for the Jewish children Interviewees
1. Tell me about yourself and about life in your village.	1. Tell me about yourself and life in your neighborhood.
2. Who is your best friend? What do you like to do together?	2. Who is your best friend? What do you like to do together?
What do you think when you see the children from the Jewish neighborhood?	What do you think when you see the children from the Arab village?
4. Please describe for me what you think the Jewish children like to do after school.	4. Please describe for me, what do you think the Arab children like to do after school.
5. Would you play with them at that place?	5. Would you play with them at that place?
Do you think you could become close friends with a kid from that neighborhood? Why is that?	Do you think you could become close friends with a kid from that village? Why is that?
Would you be willing to live in the same building as them?	Would you be willing to live in the same building as them?
Do you have an Instagram account? Would you be willing to be friends on Instagram with one of the kids from the opposite neighborhood?	Do you have an Instagram account? Would you be willing to be friends on Instagram with one of the kids from the opposite village?
Would you be willing to visit the home of one of the kids from the Jewish neighborhood?	Would you be willing to visit the home of one of the kids from the Arab Village?
If a kid from the opposite neighborhood came here, what would you tell them? What would you like to do with them?	If a kid from the opposite village came here, what would you tell them? What would you like to do with them?
Questions for Arab adult Interviewee	Questions for Jewish adult Interviewee
1. [Connect with the interviewee] Tell me about yourself and about life in your village.	1. [Connect with the interviewee] Tell me about yourself and about life in your neighborhood.
What do you think when you see the Jewish neighbors in the Opposite Jewish neighborhood?	What do you think when you see the Jewish neighbors in the Opposite Arab village?
Would you be willing to live in the same building with a Jewish person? Why is that? / Could you please elaborate?	Would you be willing to live in the same building with an Arab person? Why is that? / Could you please elaborate?
Do you think you could have been good friends with someone from the opposite neighborhood?	Do you think you could have been good friends with someone from the opposite village?
Would you be willing to be a houseguest somewhere in the opposite neighborhood?	Would you be willing to be a houseguest somewhere in the opposite village?
Would you be willing for your son to marry a Jewish woman? Why is that? /Could you please elaborate?	Would you be willing for your son to marry an Arab woman? Why is that? /Could you please elaborate?
What would you tell a Jewish family that fears visiting your home?	What would you tell An Arab family that fears visiting your home?
What do you think is the reason that some Jews fear meeting you?	What do you think is the reason that some Arabs fear meeting you?

4.4 The VR Filming

Filming the two families took place between March-May 2018. I used Google's Yi Halo 360° camera, and the filming was performed by a two-person crew: a director-interviewer (myself) and a technical assistant (David Rudoy). We did not use artificial lighting, because that would require more crew members in the family homes, which would hamper the intimacy of the interview. The interviewees were recorded with a wired lavalier microphone (DPA 461), connected to a Zoom N6 digital recorder. The footage was stitched with Mistika software and edited on Adobe Premier. The following is the credit list of the team working with me on producing the installation: Created and Directed by Daniel Landau, Translator and Content development: Samira Saraya, Documentary Researcher: Yair Sugarman, Camera: David Rudoy, Drone Operator: Aviv Kegen, Room Design: Hagar Brotman, Prop-man: Ron Rochman, Industrial Design: Elad Ozeri, Code: Sraya Harif, Eitan Hayak, Translators: Abed Natour, Software QA: Emil Landau, Production Manager: Shahar Marcus.

4.5 The common denominator

The underlying theme of *Visitors* is similar to that of Article II and Article III, namely, the Israeli-Palestinian conflict. In *Visitors,* I focus on a specific aspect of the conflict, namely the complex relationship of a large part of the Jewish population with the Arab identity. In 2012, the percentage of Mizrahi Jews (literally Eastern Jews, a term used to describe Jews of North-African and the Middle-Eastern dissent) comprised 44% of the Jewish population in Israel compared to 56% of Jews from North American and European origins (www.cbs.gov.il). This means that from a cultural perspective, a large part of Israel's population comes from and relate to Arab culture. As described by Eliyahu Levi, the Jewish grandfather interviewee, born in Tunisia: "We grew up speaking Arabic, listening to Arabic music, eating Arab food, and I had many Arab friends that were like my brothers. We had very little in common with the Ashkenazi Jews from Romania and Poland. I never trusted them." This quote encapsulates one of the most significant opportunities for resolving the Palestinian-Israeli conflict. Social processes and political forces have deliberately suppressed this key cultural common denominator between Mizrahi Jews and Palestinians. Unfortunately, the review of these mechanisms is beyond the scope of this thesis. In *Visitors,* my goal was to highlight the cultural commonalities and create a sense of familiarity between the two communities.

4.6 VR Installation Hardware and Software design

Constructing a long-term (ten months) VR installation in a high-traffic museum gallery poses considerable design challenges, specifically in terms of durability and ergonomics of the headsets. Firstly, VR is a single-user device, a limitation addressed by having six devices spread across the installation (three for each family) and by keeping the content short (under four minutes), to ensure viewing turn-over. Secondly, VR headsets are usually worn over the head, a procedure that is ergonomically impractical for high-volume exhibitions. Hence, we designed and produced an easy-to-use VR headset with two handles (Figure 4.3) that would begin to play the content automatically, once placed over the eyes, as well as custom software for playing back the VR content.

4.6.1 Custom VR Enclosure

During project development, the only available stand-alone VR headset was the phone-based VR enclosure, Samsung Gear (The first stand-alone device, Oculus Go, was released a month before the opening in the US, May 2018 – too late to be implemented in the exhibition). We used Samsung S7 as the phone powering the experience.

These were the design specifications for the enclosure:

- Protect the plastic VR headset and the phone it contains.
- Make the VR contraption robust while keeping the contraption light yet strong enough to withhold falls.
- Create handles for quick and intuitive viewing (Figure 4.3) to eliminate the need to strap on the VR headset and enable a more 'natural' interaction with the device.
- Secure the power cable. Add a steel wire to secure the device from theft and to relieve stress from the power cable and its connection to the device.
- Create ventilation holes to avoid device over-heating.
- Have easy access to the phone compartment for servicing.

After testing many prototypes, we reached an optimal custom enclosure that achieved the design objectives (Figure 1.4). Following an initial troubleshooting phase of a few weeks, we had no downtime of the exhibition for its whole duration, which was, from a technical perspective, a notable achievement for such a new medium.

4.6.2 Custom Software

During project development, there was no available software for a single-use VR application (or 'kiosk mode'). We developed a Unity-based app with the following specifications: Once the device covers the user's eyes, the playback

of the 360° video should start automatically. Once the device is removed from the user's eyes, count five seconds before resetting the clip to the beginning. The playback delay mechanism was put in place to avoid cases in which users momentarily remove the device, and the clip resets to the beginning.

4.7 Impact

During the ten-month run of the exhibition, an estimate of over two hundred thousand visitors visited the exhibition.[6] The exhibition received extensive national and international media exposure, including an article in *The Guardian* (September 20, 2018).[7] During the exhibition, I visited the installation monthly and engaged in conversation with visitors. All my conversations were with either Israeli Jewish visitors or non-Israeli tourists. Unfortunately, I did not meet any Arab visitors in the exhibition, except for the protagonist Sabateen family, whose visit to the exhibition is described in the next section.

Here are examples of some of the feedback I received:

"This was a powerful and emotional experience." /66 years old Israeli female

"I've never been to the home of an Arab family." /31 years old Israeli female

"My grandparents' house looks the same." /52 years old Israeli male

"I do feel close to the Arab family. I would consider meeting them in real life." /27 years Israeli old female

6 Our software had a counter counting number of views. Taking into account that a single visitor viewed two videos, the 413,000 playback counts amount to an estimation of over 200,000 visitors.

7 https://www.theguardian.com/world/2018/sep/20/israelis-experience-slice-of-virtual-reality-of-palestinian-home-life

4.8 The Meeting of the Families

Figure 4.4: David Avidan (left) and Raji Sabateen (right) meet at the Israel Museum

The installation *Visitors* portrayed an imaginary reality, in which two homes from almost segregated communities are accessible; where meeting Arab and Jewish families in person is a simple act. As time went by, more visitors experienced the exhibition, and I engaged in meaningful conversations with many of them. The sense of it being a public platform for encounters transcended the exhibition from an art project in the museum to an act in the complex Israeli–Palestinian reality, contributing, even modestly, to the prospect of understating the Other.

One of my objectives for this project was to have the two families meet. After several weeks of struggle to arrange a permit for the Sabateen family, on September 16, 2018, the Avidan and Sabateen families have finally met for the first time in the gallery. This private meeting was very emotional, albeit too short for developing a full conversation. Once the contact has been made, a genuine willingness to meet again was expressed by both sides. This was also my first time to hear about the experience of the installation from an Arab perspective. Yacoub Sabateen, Head of the Computer Engineering Department at Al-Quds University and the father of Mahmud Yacoub Sabateen, who appeared in the edited video, made two observations that struck me: The first was related to the Israel Museum as an Israeli national institution. He expressed his difficulty of being presented in an Israeli national institution. He

said: "Standing in front of the entrance the national Museum of Israel, seeing the Israeli Knesset in the distance (Figure 4.5), I can't ignore the fact that in that building the rules the make my life a misery are legislated."[8]

When we discussed Yacoub Sabateen's experience viewing the VR encounters, he shared a profound insight regarding the children's interviews. He noted that when the Jewish child talked about herself, she talked about her plans for the future and all the options that she can choose from. In contrast, when the Arab child was asked about himself, he didn't mention the future; rather, he talked about the Jewish kids that he sees when he passes by the Jewish neighborhood. The differences between the children's outlook on the future resonate with the reality of the Israeli-Palestinian conflict, in which one society (Israeli) is controlling another (Palestinian). This example clearly demonstrates the transposition between the macro-political context on the private psychological construct of the self.

Figure 4.5: In the foreground is the Shrine of the Book, one of the wings of the Israel Museum. In the background is the Israeli Knesset - the unicameral national legislature of Israel.

8 The Knesset is the Israeli parliament.

5. ART PROJECT II: *TIME-BODY STUDY*

Performative Experiment at Print Screen Festival, Holon, 22-25 June 2016

Created by Daniel Landau in collaboration with: Hai Cohen, Maya Magnat, Duffy Katz, Hedva Eltanani, Shani Bar

Filmed actress: Ruti Tamir
Light: Nadav Barnea
Art: Shai Govhari
Producer: Shahar Marcus
Curated by Lior Zalmanson
Produced with the support of: Print-Screen Festival, Kelim - Choreography Center, The Advanced Reality Lab, IDC Herzliya and the Oh-Man, Oh-Machine Research Group

Figure 5.1: Stage performance of Time-Body Study, Print-Screen Festival, 2016

5.1 Introduction

One of the most exciting possibilities of VR is inducing the illusion of owning a virtual body. As was established in Chapter 2.4, experiencing ourselves inside a body and the way that body interacts with the world is perhaps the most fundamental experience of selfhood. In everyday life, we experience our biological bodies as our own. It obeys our will and moves according to our intentions. Usually, we have a coherent perception of our self and our body. Our body seems to be a relatively stable entity: Every day, we see the same body reflected at us in the mirror, and it signifies for us a constant self. Although our body gradually changes over time, the idea that it may be casually mutable seems counterintuitive. The publication of the classic Rubber Hand Illusion (Botvinick and Cohen, 1998), which demonstrated how easy it is to generate in people the illusion that a rubber hand is part of their own body, was a significant turning point. Recall that for this illusion, participants were asked to put one arm on a table, which was then covered by a box, obstructing the hand from being seen. A rubber hand was placed on the table in front of the participant, where typically, their real hand would be. As they looked at the rubber hand, both hands (the participant's real hand and the rubber one) were simultaneously stroked with two brushed. When asked to rate how much they felt like the rubber hand was their own during the brushing period, over 80% of the participants reported strong ownership of the rubber hand. Since then, there has been renewed and growing interest in the impact of virtual embodiment on cognition and human behavior.

Time-Body Study was conceived as a performative experiment that explored the boundaries between body, identity, and self, using VR technology. It was designed as a live event that included a lecture and the experiment. During the experiment, a participant, wearing a VR head-mounted display (HMD), was virtually embodied in the body of a 7-year-old, a 40-year-old, and an 80-year-old person. Inspired by the Rubber Hand Illusion, *Time-Body Study* created the virtual-embodiment illusion by having participants see their virtual hands being touched in the virtual space, while simultaneously (and in perfect sync), their real hands were being touched by a live performer. To the virtual-embodiment experience, I added narrative layers in an attempt to explore the cognitive mechanism of accepting the rubber hand or the virtual body as the participant's own, on an emotional level as well. The audience got to see both the participant's view of the virtual body (projected onto a large screen) and the live performer's interactions. This gave the audience a unique view of the experiment, demonstrating how the human body is effectively an evolving medium subjected to its technological environment.

5.2 Artistic motivation

Virtual embodiment has become an established methodological paradigm for studying the psychological and neural correlates of situations that are impossible in the real world, such as gender or age switching (Banakou, 2016, Matamala-Gomez 2019, Bailey, 2016, Hoffmann, 2013). Thus far, full-body ownership illusions have been implemented by using real-time body tracking and avatars based on computer-generated imagery (CGI). Moreover, the majority of research focused on behavioral mechanisms, while very few studies explored the emotional impact of this unique experience, and hardly any artistic initiatives explored the potential of virtual embodiment for storytelling (De la Peña et al., 2010). The high cost and inaccessibility of current virtual embodiment systems hinder the creative community from exploring this technique.

The successful adaptation of new technologies generally follows these steps:

- The introduction of a novel, expensive, experimental technology
- Initial experiments are limited to people with access to that technology.
- As the technology improves, it becomes more stable and cheaper.
- Artists experiment with the technology and help define its grammar.
- The technology is widely adopted (mass media, mainstream channels, big corporations).
- Big corporations create business models to commercialize the technology.

This process can be regarded as 'technological gentrification' – a term I coined to describe the market forces behind initial inventions to corporate control. Technological gentrification can be historically identified in the implementation of other media such as Radio, Photography, Cinema, TV, Internet, and Social Media (McChesney, 1998).

In *Time-Body Study*, I introduced an alternative technique to induce perceived ownership over a (photorealistic) virtual body, by using 180° stereoscopic video, synchronous touch, and narration. My goal was to design a method as a building block for narrative work. Since this technique is new and unexplored, yet it requires very accurate administration, *Time-Body Study* can be considered an etude. Once the method is established, it can become a useful technique for narrative, theatrical, and performative arts, education, and entertainment.

5.3 Method

To create the VR experience, we used a 180° stereoscopic video-based virtual embodiment technique that consists of three main factors: first-person view of the virtual body, synchronous visuotactile stimulation, and a narrative layer with context-specific 'passive' motor actions.

5.3.1 First Person View of the Virtual Body

In order to produce a first-person view of the virtual body, a target person (an actor) is filmed in a 1PP. This footage will serve as the virtual body of the participant. The target is filmed by placing a stereoscopic 180° camera rig with 220° fisheye lenses in front of their eyes (Figure 5.2).

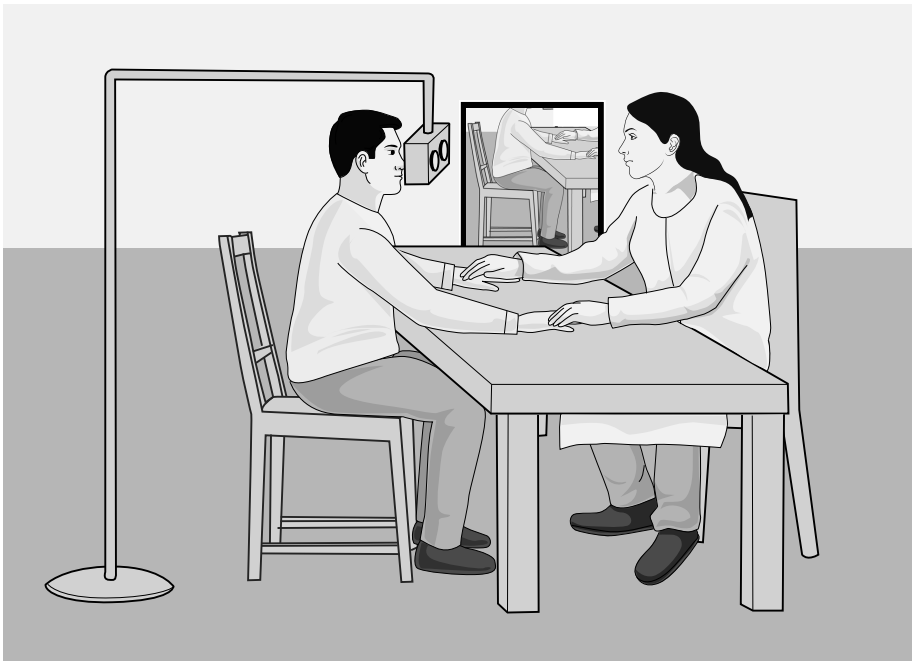

Figure 5.2: The technical setup of the 1PP shoot

The target is seated at a table with their hands placed on it. A mirror set to the left or right of the target allows the camera to capture their body's reflection without showing their face. Avoiding filming the target's face serves two goals: it reduces the perceived differences between the participant and the target, thus facilitating self-identification with the surrogate body; and it allows for participants to rotate their heads freely without "disconnecting" from the virtual body (e.g., avoiding instances in which the virtual body faces forward while the participant turns their head sideways).

5.3.2 Synchronous visuotactile stimulation

The second component of the 180° video-based embodiment technique is synchronous visuotactile stimulation. This stimulation is an integral element in related studies, such as the Rubber Hand Illusion (Botvinick and Cohen, 1998) and the 'Enfacement' Illusion (Porciello et al., 2018), as well as in video-based techniques used to elicit out-of-body experiences (Ehrsson, 2007). Synchronous visuotactile stimulation is also applied often in CGI-based full-body ownership studies (e.g., Maselli and Slater, 2013). Another person, who serves as a virtual interlocutor with the participant in the embodiment experience, is seated in front of the target on the other side of the table and performs a 30-second sequence of tapping and stroking on the target's hands. This sequence is equivalent to the induction of the rubber hand in the Rubber Hand Illusion. The purpose of this procedure is to establish a visuotactile sensorimotor contingency (Slater et al., 2010), whereby the participant not only sees another person's body replacing their own but also sees the touch on that person's hands while simultaneously feeling a synchronized touch on their own hands. The tapping sequence is performed to the sound of an 80-beat-per-minute (BPM) metronome to ensure synchronization. The tap and stroke sequence was choreographed and transcribed (Figure ⁋5.3; legend: a red dot indicates a tap, a red line indicates a long stroke, and a rest sign indicates a pause). This score served both the virtual interlocutor and the performer in the embodiment experience. In addition to performing the touch sequence, the interlocutor spoke to the target and instructed them to look down at their hands and then to their left to observe the virtual body in the mirror (these instructions will also be used in the subsequent embodiment session).

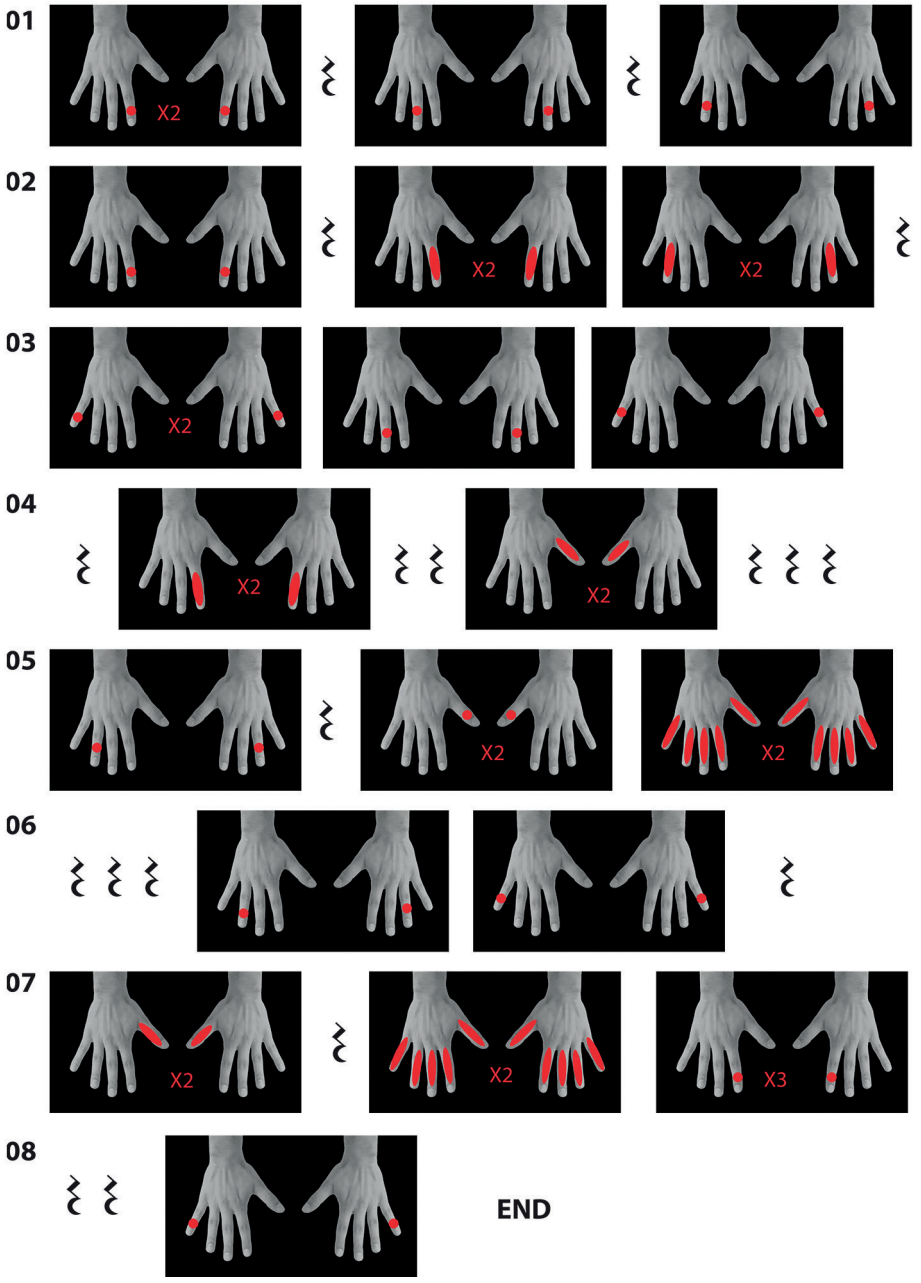

Figure 5.3: The score for the touch sequence

5.3.3 The narrative layer and context-specific 'passive' motor actions

Evidence shows that enriching the experience of embodiment beyond a purely physical perceptual illusion with a narrative context can increase the participant's engagement (Shin, 2018), and possibly create a more profound and long-lasting impact on the participant. Therefore, after the touch sequence, which aimed to establish the illusion of virtual body ownership, I added a narrative layer. As part of the narrative layer, I recorded the virtual interlocutor and the target performing motor actions, such as the interlocutor placing context-specific objects in the target's hands, guiding their hands into specific positions, or performing certain motions and gestures, such as a handshake. These pre-recorded interactions were later executed in synch by the experimenter on the participant's arms and hands during the embodiment phase of the experiment. These passive forms of inducing visuomotor correlations compensate, partially, for the participant's lack of agency. Hence, the narrative layer fulfills two purposes: it adds a contextual meaning to the embodiment experience through storytelling, and it circumvents technical limitations of the video-based embodiment technique, at least partially.

5.4 Embodiment experience

In order to embody participants in the target body, the 180° stereoscopic video was played back using a VR headset and headphones. The participants sat at a table and placed their hands in the same location as the virtual hand. They were instructed not to initiate hand movements but were encouraged to turn their heads and look around. The experimenter, like the virtual interlocuter, sat at the opposite side of the table and listened to the video via headphones. The experimenter performed the tap and stroke sequence in complete synchronization with the pre-recorded sequence (with the aid of the 80 BPM metronome beat). The experimenter also simulated the virtual interlocuter's other actions, such as placing objects in the participant's hands. These actions were added to create a narrative.

Note that the synchronization of the recorded and live visuo-tactile stimulation is crucial because even a slight deviation (i.e., asynchronous strokes) can break the body ownership illusion (see Kokkinara and Slater, 2014).

5.5 Data Collection

After the experiment, participants (N=51) were interviewed in a semi-structured interview method (Barriball et al., 1994). We asked all participants: "If you had to tell a close friend about the experience you just had, what would you tell them?" We recorded and transcribed all interviews and used them to assess the emotional impact experienced by the performance/experiment.

6. ART PROJECT III: *SELF-STUDY*

Performative Experiment at B3 Film Festival
Frankfurt, 9-18 October 2017

Created by Daniel Landau in collaboration with Maya Magnat. Research assistant: Bennet Hübbe, Production manager: Shimrit Gil. Special thanks to Maya Sharabani.

As the final art project of my research, *Self-Study* is the culmination of all the work presented so far. While in Art Project I (*Visitors*) participants got to virtually meet the 'other,' and in Art Project II (*Time-Body Study*) they embodied another person's body, here I wanted to create for them the experience of meeting (as opposed to seeing) themselves.[9] To achieve this, I devised an intervention in which a participant could meet themselves in VR. Reflecting on the evolution of imaging technologies and their impact on shaping the self, I was eager to explore the potential impact of VR on this fundamental human construct.

6.1 Introduction

Research in the field of compassion has shown that it is generally easier to express compassion to others than to oneself (Neff 2003). In this study, I used immersive 180° stereoscopic video to create an immersive VR environment in which participants experience the illusion of meeting their own selves. By using video editing techniques and a live performer to simulate touch, participants were able to 'look into their own eyes,' physically 'hold their own hands,' and listen to compassionate words spoken to them by themselves.

6.2 Method

We ran the *Self-Study* experiment as an art performance at the 2017 B3 Biennial of the Moving Image in Frankfurt. Our goal was to explore the impact of a virtual encounter between a person and themselves. In particular, we wanted to find out whether such intervention could increase self-compassion and a sense of intimacy within oneself, improve the perception of body image,

9 As was discussed in section 2.4, we can feel ourselves from within while simultaneously see parts of our bodies from the outside (e.g., looking at our hands, or looking into the mirror).

and contribute to one's wellbeing. Ten participants completed the experiment and were later administered a semi-structured interview.

To create an interaction between participants and themselves, we met each participant for two separate sessions. In the first session, each participant was filmed with a 180° stereoscopic camera system. During this session, they were asked to perform a sequence of tasks, at the end of which they sat in front of the 180° stereoscopic camera, touching the hands of a confederate, and addressing them compassionately as if they were a close friend. A few days later, in the second session, the edited footage of the first session was played back to them on a head-mounted display (HMD), with a live performer simulating physical touch in sync with the pre-recorded virtual touch visible in the HMD. At that point, their kind words for a close friend from the first session were now addressing them.

6.2.1 Part 1 – The Recording Session

Figure 6.1: Experiment/ Performance view from B3 Festival - November 2017, Frankfurt

6.2.1.1 The Mirror-Game

The sessions were recorded from the 1PP of a confederate sitting on a mat, behind an Immersive 180° stereoscopic video camera. The experiment began when the participant entered the room and was greeted by a female experimenter (Figure 6.1). After the greetings, she handed the participant a custom-designed jacket with extendable sleeves, identical to the jackets she

and the confederate were wearing. After asking the participant to take a deep breath, she invited them to play the 'mirror-game,' an improvisation technique in which one person is performing a movement sequence, while the other is mimicking them as if they were their mirror reflection (Noy, 2011; Figure 6.2). The sequence ended with the experimenter and the participant touching hands, with the whole sequence captured by the 180° stereoscopic camera.

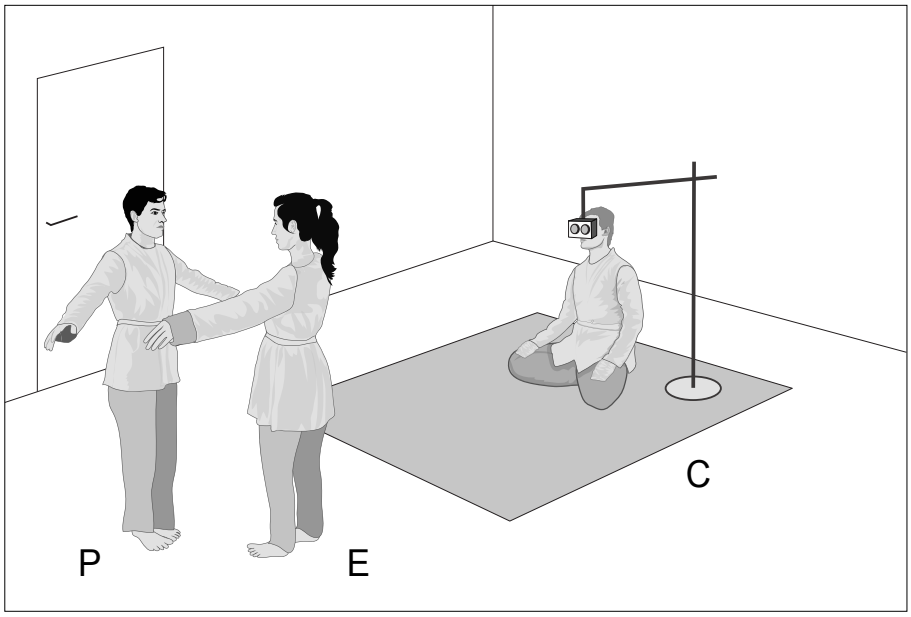

Figure 6.2: Participant (P) playing the 'mirror game' with the experimenter (E). The confederate (C) is sitting behind the 180° stereoscopic Camera wearing the custom-made jacket with its sleeves covering his hands. In the second viewing session, the confederate's body will *seem to the participant like his own body, because they will be wearing the same jacket, and his hands will be covered as well.*

6.2.1.2 Compassion towards another

After the mirror-game, the participant was instructed to sit in front of the confederate and look into the lens of the camera. The experimenter then gave the following instructions:

> *"Close your eyes. I want you to imagine that you are sitting in front of a person that you feel very close to. This person is going through a really rough time. Now open your eyes and look into the camera. Place your hands on the hands of the person in front of you. Take a minute and tell the person that you were thinking of all the things that you like about them."*

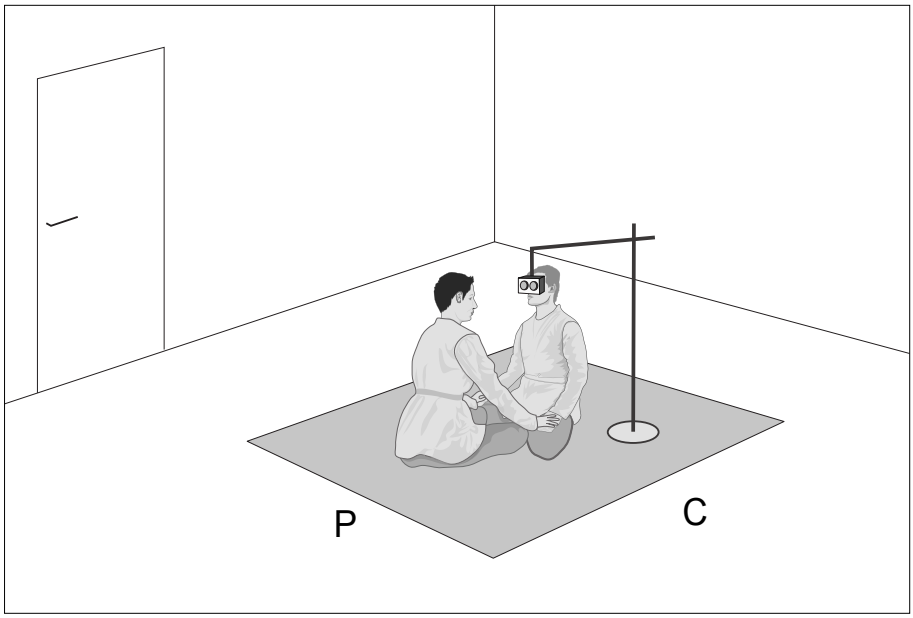

Figure 6.3: Participant (P) sitting in front of the confederate (C), holding his hands, and looking into the camera, imagining a close friend, and saying all the good things he feels about his/her friend. This recording will be played back to the participant during the second session.

6.2.1.3 Embodying the participant in their own body

After the participant finished talking to the confederate, they were requested to take a seat behind the 180° stereoscopic camera (Figure 6.3). Once the participant sat behind the 180° stereoscopic camera, the experimenter sat down in front of them and repeated the movement sequence she did while standing. This sequence also ended with the experimenter touching the hands of the participant. This sequence aimed to establish the participant's 1PP in their own body for the viewing session of the experiment. In the viewing session, the participant donned an HMD, in which they could see their own body from 1PP. The mirror game was used to establish a sense of agency by moving and seeing their own body in the HMD. The touch at the end of the sequence was another sensory cue to help intensify the illusion that the body seen in the HMD was the participant's own.

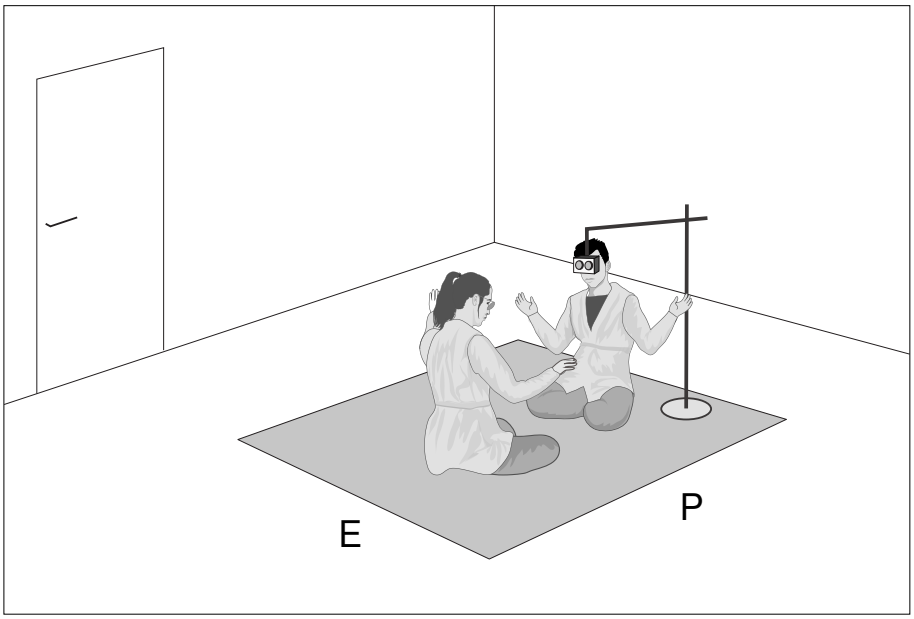

Figure 6.4: The participant (P) is seated behind the 180° stereoscopic camera, playing the mirror game led by the experimenter (E). This recording will be played back in the second session and will establish the 1PP of the participant.

6.2.2 Part 2 – The Viewing Session

In the second session, the participants viewed an edited and dubbed version of the footage that was filmed during the first session. The editing and voice-over intended to achieve two manipulations: Body swap – biasing the participants into believing that they see themselves in both 1PP and in third-person perspective (3PP). Interview swap – having the compassionate words that they expressed thinking about someone else directed at them.

6.2.2.1 Embodiment in one's own body

The second session began with the experimenter greeting the participant and handing them the jacket they had worn in the previous session. Next, the participant was instructed to sit on the mat, where the confederate sat during the first session. Recall that the entire scenario was filmed from this perspective. The participant donned an HMD, which displayed the same room. Upon looking down, the HMD showed the participant their own physical body, as it was filmed in the first session, from 1PP (Figure 6.4). Next, the participant viewed the footage of the experimenter entering the room and sitting in front of them. In the video, the experimenter asks the participant to take a deep breath and to play the 'mirror game' with her (Figure 6.5). The participant followed the experimenter's recorded movements with the sequence ending

with their hands touching. At that point, the experimenter touched the hands of the participant in sync with the screened touch, thus generating a sensory integration. The goal of this part was to fully establish the illusion of the participant being physically present in the room with visual, auditory, motor, and tactile information contributing to complete this illusion, similar to the Rubber Hand Illusion (Botvinik and Cohen, 1998).[10]

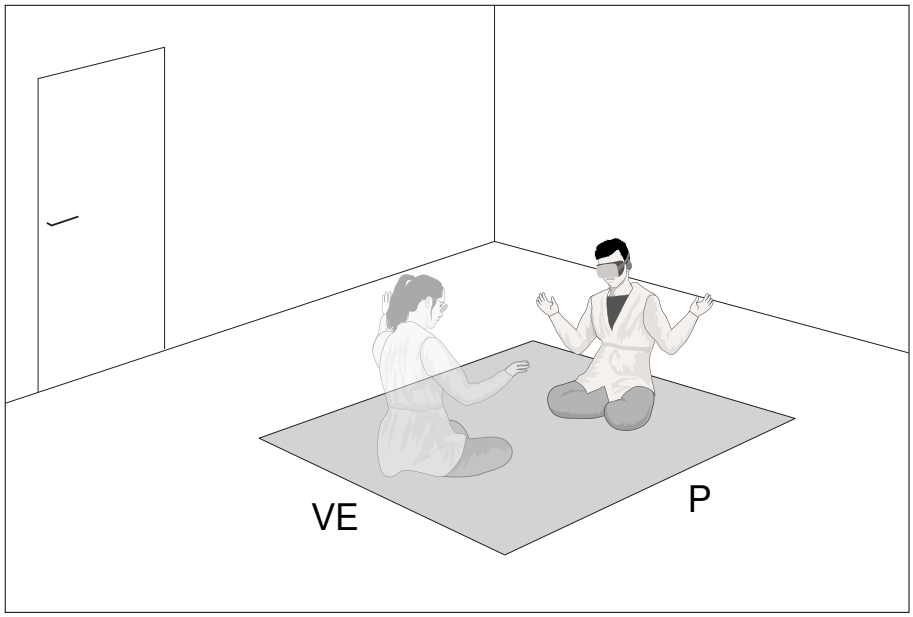

Figure 6.5: The participant (P) sees the virtual experimenter (virtual embodiment) in the HMD and follows her directions in the 'mirror game.' As he physically performs the movements, he will see his own hands in the HMD performing the same sequence as they were recorded in the first section

6.2.2.2 'I' enter the room

Next, the participant heard, via the headset, the voice-over asking them to close their eyes. At the same time, the experimenter unfolded the sleeves of the participant's jacket to cover their hands, so that once they open their eyes, the body swap would be in place. The objective was to prevent them from noticing that their virtual 1PP body actually belonged to someone else, since the virtual body was wearing the same jacket as they were, and its virtual hands were similarly covered. The editing of the immersive video footage allowed the

10 For an elaborate description, see sections 2.4

participant to see their virtual self entering the room and being greeted by the virtual experimenter (Figure 6.6).

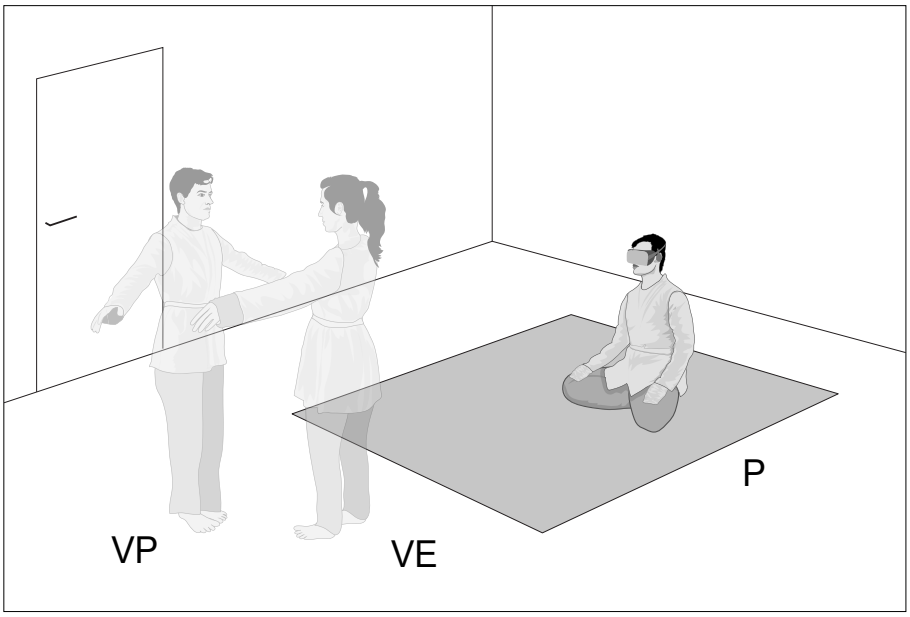

Figure 6.6: The participant (P) sees his virtual self (VP) enter the room playing the 'mirror game' with the virtual experimenter.

6.2.2.3 Compassion for oneself

After the mirror-game sequence, the participant watched their avatar come to sit in front of them (Figure 6.7). They saw and felt 'themselves' touching their own hands. This viewed touch coincided with the live experimenter physically touching their hands. Then, they heard the following voice-over text:

> *"Look at yourself. Look into your eyes. What do you see? Feel the touch on your hands... Now, think about times when you feel bad or are struggling. How do you typically respond to yourself in these situations? What do you typically do, what do you say?"*

At that point, the pre-recorded self turned to 'look into their own eyes'; the compassionate words that were originally intended for someone else were now addressing them.

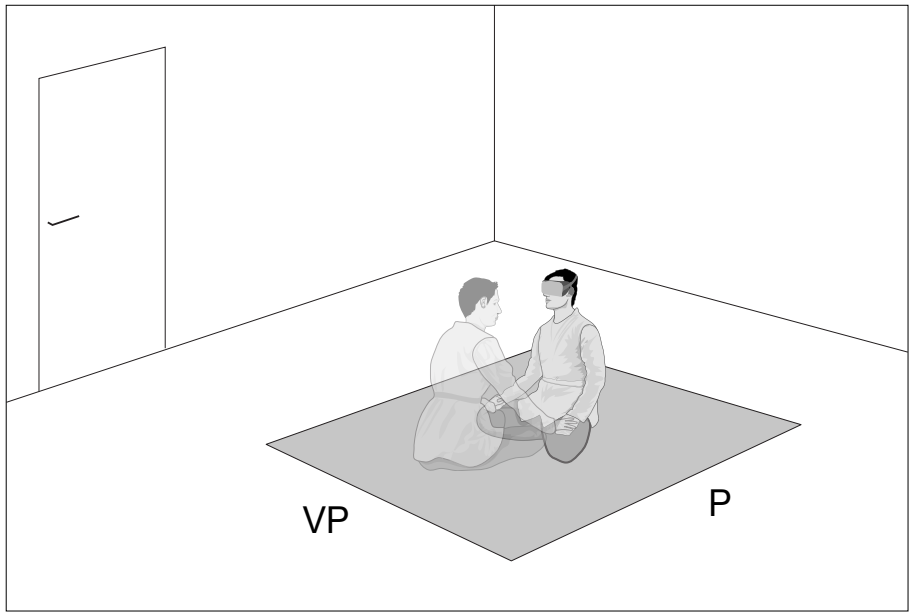

Figure 6.7: The participant (P) watching his virtual self (VP) on the HMD. The virtual self is touching his hands while, simultaneously, the experimenter is physically touching the participant's hands, thus creating a visio-tactile sensory integration.

6.3 References

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6.4 Discussion

Our main conclusion is that meeting oneself in VR using a 180° stereoscopic camera is an experience like nothing experienced before. Participants reported that the impact of meeting themselves through the immersive experience of the *Self Study* intervention was fundamentally more powerful than seeing themselves in a mirror or watching themselves on video. In particular, participants reported that the human touch part of the intervention produced a very profound and meaningful moment, especially while hearing their own voice addressing them. Participants reported that the experience felt like a 'real encounter,' and that they would like to further explore where it could lead. We also found a main effect of body image on how positive participants felt in the experience: The better the participants felt about their own body, the more positively they perceived the experience. This experiment was repeated in a sci-art study with 80 participants and systematic data collection. In this follow-up study, we have used the proxemics measure, HRV physiology, and questionnaires. It will be written as a full empirical paper.

7. DISCUSSION

In this chapter, I discuss the impact of VR and virtual embodiment on the self-other binary. First, I summarize the reported findings, then, I discuss the implications of these findings, and finally, I propose a framework for future applications and present my plans for follow-up research.

7.1 Summary of the Main Findings

Article I demonstrates that a VR experience, which simulates a face-to-face encounter, when filmed from a distance of the standard personal distance (80-90 cm), can significantly elicit empathic care for another person (the target), compared to 2D video. So far, the reason for this effect is unclear. A possible explanation is that the sense of sharing a space with another person, as though they were present in the physical space, allows the participant to reach out and support the target by holding their (virtual) hands and providing a compassionate gesture. Further research is needed.

Article II shows that experiencing ingroup aggression from the perspective of the outgroup increases empathy towards the outgroup compared to seeing the same scenario from the ingroup's standpoint.

Article III compares the emotional impact of 2D vs. VR media. Effectively, the immersive experience of a check-point scene led to more hostile emotions towards the soldiers (but not more empathy towards the Palestinians) and thereby resulted in the judgment of the soldiers' actions as less moral and less justified, compared to seeing the same scenario as a 2D video on a screen. These findings attest to the potential of VR to become a part of a broader societal intervention and to impact groups in conflict.

Article IV Introduces a novel technique for inducing a sense of ownership over a virtual body, using accessible 180° stereoscopic video.

Art Project I establishes the impact of a museum exhibition on raising awareness and driving a conversation within the Israeli-Palestinian conflict.

Art Project II establishes the possibility of using narratives in a virtual embodiment experience while using 180° stereoscopic video. Further development and experimentation are needed to establish the role of the participant as a 1PP protagonist.

Finally, **Article V** and **Art Project III** establish an experimental stimulation that lets participants meet themselves in VR. Current partial results indicate that this is a transformative experience. However, further research is needed in order to measure its impact empirically.

7.2 Research Implications

Articles I, II, and III establish specific VR methodologies for inducing empathy.

Article IV presents the possibility of an accessible virtual embodiment technique, and Article V demonstrates the application of this method for inducing self-compassion.

All of these artifacts use immersive video, which has the main advantages of being visually realistic, accessible, and relatively easy to use. Furthermore, the use of video offers the possibility to contextualize such interventions by using real places, events, and people. To date, there is no CGI, real-time VR workflow that can achieve visual realism. Although this may change in the near future, the CGI production process is more labor-intensive than a 180° stereoscopic video production.

The Future of Storytelling

One of the fundamental motivations for executing the projects reported here was to establish a basic grammar for embodied storytelling. In Article IV and Art project II, I used storytelling elements as part of the virtual embodiment procedure. Now that the 1PP 180° stereoscopic video virtual embodiment method is established, it opens up new possibilities for creating narrative performances.

The Future of Empathic Interventions

Articles I, II, and III provide valuable insights on how to use VR for empathic interventions. Since starting this work, I have been involved in several projects using VR for psychological interventions aimed at increasing empathy, sense of belonging, and social cohesion. It is a matter of time, experience, and market adoption of VR devices, for VR interventions to become a plausible tool of choice for social interventions and therapeutic applications.

7.3 Follow-up studies and Projects

Each of the research projects reported here could be considered as the first step for many follow-up studies set to deepen the understanding of the underlying mechanisms and components of virtual embodiment, narrative, context, empathy. I would need to explore various applications of using virtual embodiment as a creative platform for art projects rooted in scientific findings.

As a follow-up study for Article I, I plan to validate a new implicit method for measuring degrees of empathy towards a target, with a goal to create a VR version of the proxemics measure (Hall, 1968). Proxemics is a tool extensively used in experimental psychology to explore the self-other merge. The prevalent version of proxemic assessment is a computer-based stick figure application in which the participant needs to report what distance feels comfortable as the figure moves closer to another figure defined as the participant. Greater physical distance is assumed to correspond to greater psychological distance (i.e., less self-other overlap). As a methodology, I would like to design an immersive stimulation in which a target moves towards the participant. Once the comfortable interpersonal distance is crossed, the participant presses a trigger.

In Article II and III, we demonstrated the power of VR to increase outgroup empathy. This suggests that VR has the potential to assist with conflict resolution. We are currently working on several designs, inspired by Art Project I (among other things), to provide various cultural contexts for a virtual embodiment experience. We want to explore the impact of becoming the outgroup as a means to increase empathy and understanding.

One of the techniques we are developing is Virtual Enfacement, which would make it possible to not only embody a participant in a different body but also to lend them the face of another person. Currently, we are isolating and investigating parameters such as cultural context (elements in the room), hands embodiment, and face enfacement – with the goal of formulating paradigms to blur the self-other gap.

7.4 Epilogue

This dissertation was written amid the COVID-19 crisis. The world is experiencing a new reality in which millions of people around the world are confined to their homes, unable to meet friends or family for weeks on end. Face-to-face encounters have been replaced by mediated video conferencing technologies, radically transforming the way we interact with others. As social VR technologies develop and virtual embodiment experiences become increasingly accessible and popular, we can expect a rising need for profound and meaningful experiences related to motivational empathy and social change. This study demonstrates the benefits of using VR and virtual embodiment experiences as communication technologies. However, improving digital communication to simulate real-life encounter is only one possibility. Using digital editing and processing techniques may generate encounters that would otherwise be impossible, such as meeting people from various outgroups or meeting people no longer alive. Virtual embodiment technologies may lead to a reality in which individuals can choose their physical appearance; in some

cases, avoid prejudice and biases, and add another layer of expression to their internal desires. Understanding the nature, quality, and dynamics of virtual embodiment and virtual social encounters holds a promise to facilitate the design of meaningful social experiences for a wide range of applications such as therapy, heritage, conflict resolution, art, and education.

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